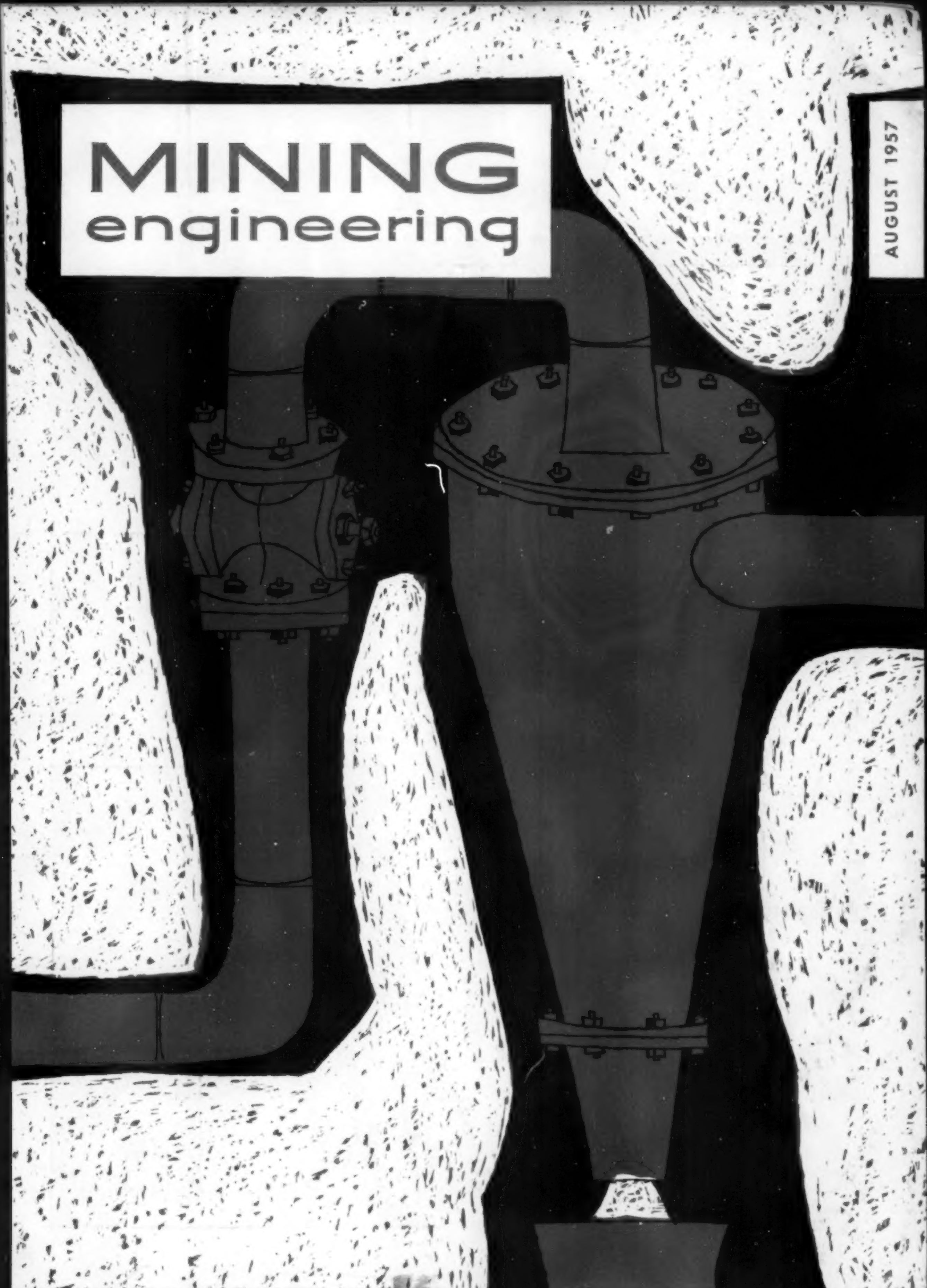
# MINING engineering

AUGUST 1957



The AIME also publishes **Journal of Metals** and **Journal of Petroleum Technology**

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# MINING engineering

VOL. 9 NO. 8 AUGUST 1957

## COVER

**Old in principle, the cyclone only came into its own in beneficiation during the past decade. The symposium starting on page 869 presents some of the facets of its phenomenal growth of application. Cover artist, Herb McClure.**

*Know Your Society*



## SYMPOSIUM ON CYCLONES



## ARTICLES



## FEATURES

# PERSONNEL

THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service, Inc. (Agency) operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18**; 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

## —MEN AVAILABLE—

**Mining Manager,** E.M. degree, age 39. Fifteen years experience exploration, development, construction, and exploitation Excellent record in production, costs, and labor relations. Location desired, West. M-340.

**Mining Manager or Superintendent,** B.A. in geology, age 57. Continuous progressive experience in metal mining since graduation in 1923, nonferrous industry. References cover work in North and South America and Europe. Desire responsible management job with bonus or participation. Location, immaterial. M-341.

**Mining Engineer,** 30, single, mining engineering degree. Three years experience underground and some open pit mines (gold, tin, tungsten). Interested in locating South or Central America. Spanish speaking, familiar with people, customs, and high altitude working conditions, with ability to handle native personnel. M-342-219-San Francisco.

**Metallurgical Engineer,** B.S., 37, 11 years production and research experience in hydrometallurgy, milling, electrowinning, and electrorefining, sulfuric acid manufacture. Excellent production and personnel relations record. Current rank assistant superintendent. Desires position with future. M-343.

**Mining Engineer,** B.S. in mining from Royal School of Mines, London University. Age 27, married, one child. Four years post graduate experience large central African copper mine; 2 years learner miner official's course; 1½ years underground shift boss; 6 months senior study officer (present position). Presently located in Africa. Preferable location, U. S. or South America. M-344.

**General Superintendent,** graduate mining engineer, 37, married. Seven years supervisory experience in underground and open pit mining and

*(Continued on page 824)*

**Additional classified advertising appears on page 824**

**_Above ground or down below_**

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**_helps speed production_**

***A Gardner-Denver check list of fast, safe mining equipment***

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## Personnel

*(Continued from page 822)*

quarrying operations; three years crushing, grinding, and beneficiation experience. Negotiated labor contracts and handled labor relations. Directed activities of engineering and geological departments. Available one month's notice. Location, U. S. or Canada. M-345-820-Chicago.

### — POSITIONS OPEN —

**Engineers for a Mining Operation.** a) *Mechanical-Electrical Engineer,* with experience in power generation and transmission motors, installation and maintenance, machine shop, etc., for gold lode property. Basic salary, $7800 to $8400 a year; social benefits provided by local law bring salary up to approximately $9,420 to $10,080 a year. Furnished house provided free of charge. b) *Assistant Mill Superintendent,* with experience in cyanidation and lead flotation plants for 500-tpd gold mill. Basic salary, $6000 a year; social benefits provided by local law bring salary up to approximately $7260 a year. Furnished house provided free of charge. Location, South America. F5163.

**Senior Research Engineer (X-Ray),** under 55. 1) *Mineralogist, Geologist, or Soil Science Major,* preferably M.S. or Ph.D. degree, with strong specialization in use of X-ray diffraction and X-ray spectrometry (fluorescence) as applied to composition determination; must be able to develop own methods. Prefer Ph.D. with none to three years experience; M.S. or B.S. with two to ten years experience. Salary, $7,860 to $10,200 a year. Location, California. W5162.

**Engineers for Gold Mining, and Chrome Operation.** a) *Geologist.* b) *Mining Engineers.* Applicants should have at least five years practical experience, preferable ten years; college degree required. Starting salary, 1200 pesos per month, with transportation for employes and family; furnished house, water, light, and fuel supplied free of charge; if single, will live in staff mess house, room and board 90 pesos per month. Location, Philippine Islands. F5160.

**Geophysicist-Geologist,** to 35, bachelor's degree in geology or physics, with minimum of five years practical experience as qualified geophysicist. Should be capable of planning and conducting preliminary preparations for geophysical work on various projects; evaluate reliability of results and make geological interpretations of seismic data; coordinate and evaluate gravimeter and magnetometer work in relation to reflection seismic work. Salary, to $10,200 a year. Single status preferred; one-year family separation, if married. Location, Far East. F5157.

**Geological Librarian,** preferably female, bachelor's degree, preferably in geology or related science, for responsible position in nonferrous metal exploration department. Will do literature searches and report writing requiring familiarity with standard bibliographies and sources; surveying technical literature; do map work with respect to active exploration projects, etc. Salary, $4200 to $4800 a year. Location, New York. W5132.

**Administrative Assistant,** degree in mining engineering or geology, 27 to 32, with three to six years field experience in mining or geology, to prepare ore and metal studies considering economic as well as technical aspects; review reports on *outside* properties to determine potential as mining ventures and summarize important facts; review monthly progress reports from subsidiary companies, etc. Salary, $6000 to $9000 a year. Location, New York. W5131.

**Field Geologist** for large construction firm operating in Peru. One to two years experience in the field. Single status. Salary, $7200 a year plus room and board. Three-year contract. F5124.

**Research Engineer,** mineral beneficiation, 24 to 35, M.S. in mineral beneficiation, one to three years experience. Experience preferred in research or development facilities with broad interests, i.e., not specializing in one phase of mineral beneficiation. Experience in operations of a mineral beneficiation plant processing nonmetallics acceptable. Salary, open. Location, West Coast. W5112.

**Junior Mining Engineers,** two, for dredging operation. Spanish desir-

*(Continued on page 912)*

# BOOKS

**•ORDER BOOKS SO MARKED THROUGH AIME—**
Address Irene K. Sharp, Book Dept. Ten percent discount given whenever possible.

**Ore Microscopy** by Sigmund L. Smith, *Sturm & Smith Publishers*, P.O. Box 4063, University Station, Tucson, Ariz., 2nd ed., $10.00, 1957.—A new technique for the rapid determination of ore value by studying it under a microscope is the subject of this textbook. It is the only book of its kind and is based on more than ten years of studies and experiments made by the author who is professor of metallurgy at the University of Arizona College of Mines. The microscopic techniques developed by Prof. Smith combine the art and science of the geologist, together with the results of investigations by mining and metallurgical engineers. •

**Flotation Plant Practice** by P. Rabone, *Mining Publications Ltd.*, 482 Salisbury House, London E.C. 2, England, 4th ed, 255 pp., approx. $5.00, 1957.—This volume has been written mainly for "the man in the plant." Data on machines has been restricted to those in use. •

**Minerals Yearbook, 1953**, Area Reports, Volume III, by the staff of the U. S. Bureau of Mines, *Superintendent of Documents*, U. S. Government Printing Office, Washington 25, D. C., $3.75, 1133 pp., 1956.—*Yearbook* material has increased to the point where it is impractical to publish it under one cover. This third volume completes the Yearbook for 1953. Volume I, *Metals and Minerals (Except Fuels)* ($4.00) contains chapters on mineral commodities, a chapter reviewing these industries, a statistical summary and recapitulation, and chapters on mining technology, metallurgical technology, and employment and injuries. Volume II, *Fuels* ($2.25) consists of chapters on each mineral-fuel commodity, as well as chapters reviewing the industry as a whole, a statistical summary, and an employment and injury presentation. Volume III is made up of chapters covering each of the 48 States, plus chapters on Alaska, the Territories and island possessions in the Pacific and the Caribbean, including the Canal Zone. It also has a chapter recapitulating its statistics in summary form on a regional basis and another presenting employment and injury data regionally. Volume III, 1953, is essentially a reissue of the material covered in Volume III, 1952.

**Mining Year Book, 1957**, compiled by Walter E. Skinner, *Walter E. Skinner*, 20 Copthall Ave., and *Financial Times*, 72 Coleman St., London E.C. 2, England, 825 pp., $7.00, 1957.—This book features complete and up-to-date particulars concerning mining companies operating in all parts of the world. Gold, silver, copper, tin, lead, zinc, diamond, uranium, and other mines; collieries; exploration; and mining finance companies are listed in alphabetical order. Information given for each company includes the names of directors and other officials, date of incorporation, seat of operations, descriptions of property, plant erected or in process of completion, present working results, ore reserves, details of capital, dividends paid, and the financial position as disclosed by the latest accounts. Highest and lowest prices of the shares are quoted for the last three years. Other indexes included in the yearbook give the names, addresses, and company affiliations of over 1200 mining engineers; world production tables of gold and base metals; and a buyers' guide, listing firms supplying mine plant equipment, accessories, etc. •

**Handbook of Chemistry and Physics**, *The Chemical Rubber Co.*, 2310 Superior Ave., Cleveland 14, Ohio,

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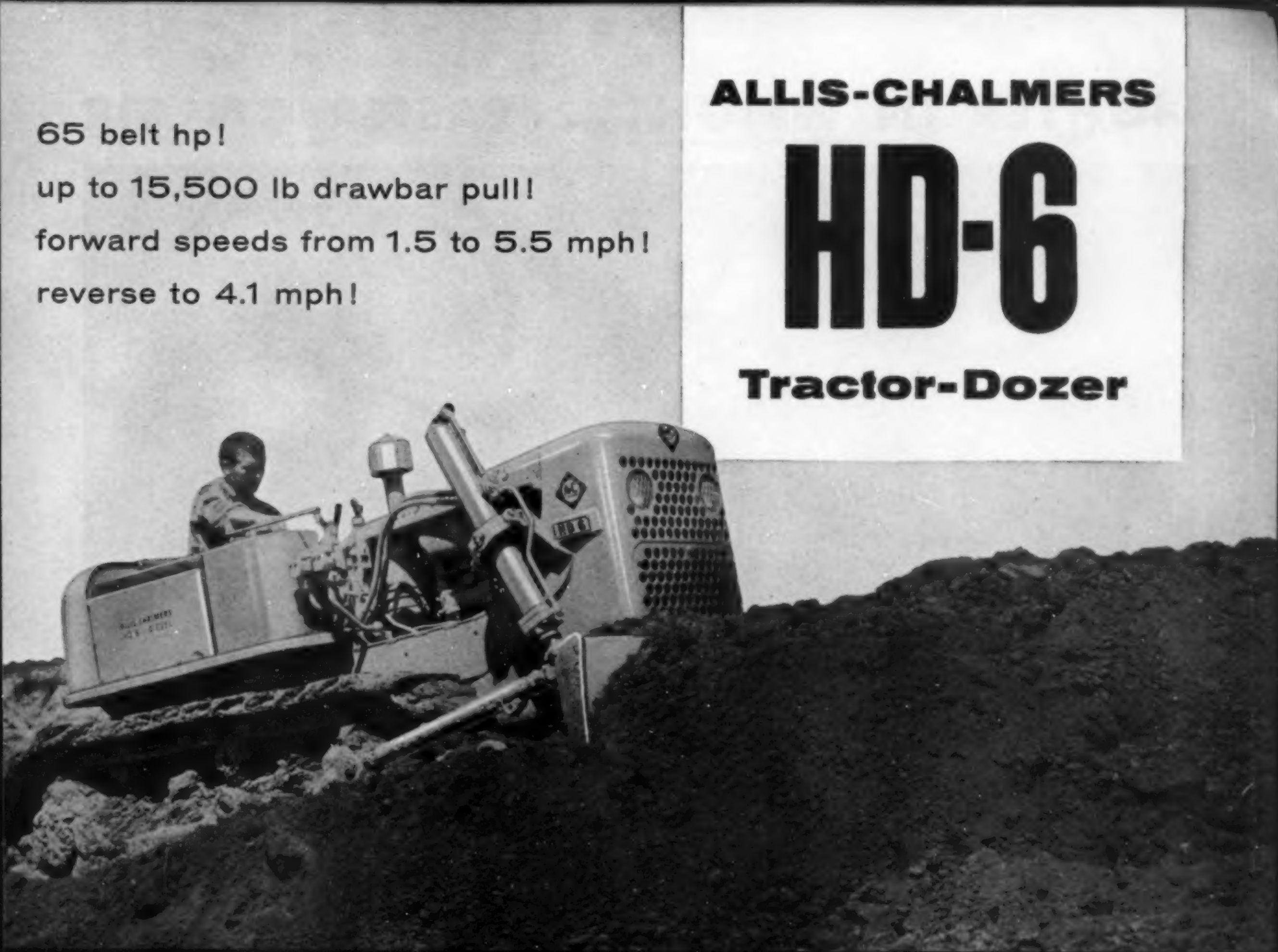

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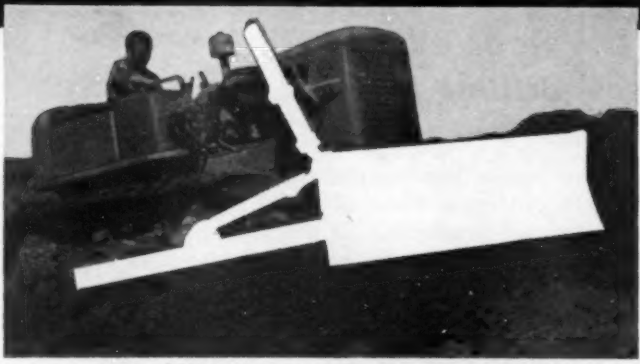

**Only dozer of its size with these basic advantages** . . . engine-mounted rams, long push beams, fewer linkage points (only 2 instead of 5 or 6). These big-dozer features all combine to provide more accurate, gouge-free dozing . . . longer equipment life.

**Convenient rotary-valve blade control** makes the HD-6 the easiest handling dozer of its size. With more than 5½ feet of track on the ground, it has outstanding flotation . . . yet turns easily in any terrain. The HD-6 also combines large, low-set front idlers with a blade snugged close to the radiator guard . . . to provide balance that means better dozing, more work done under any conditions!

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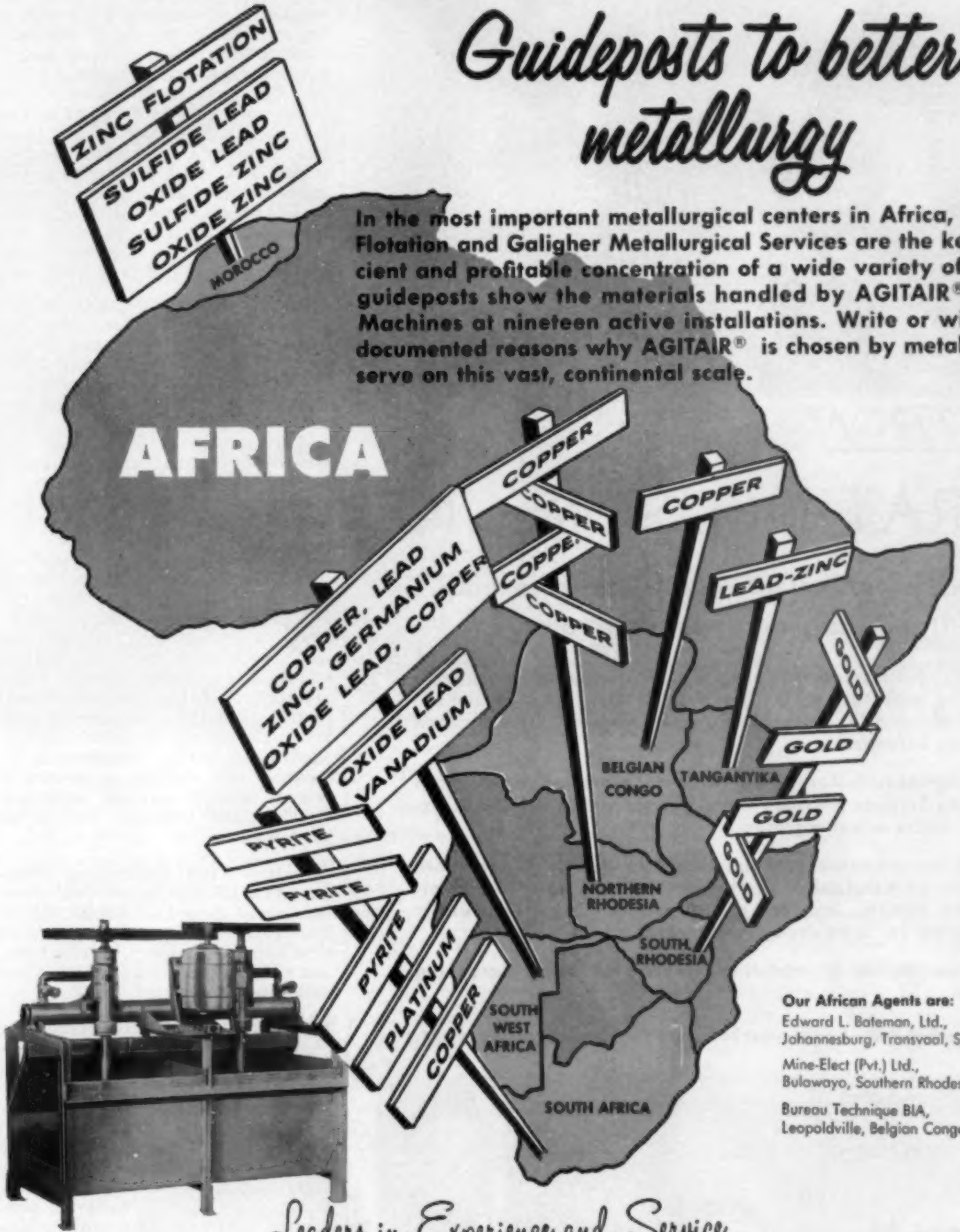


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**GALIGHER PRODUCTS: AGITAIR® Flotation Machine, VACSEAL Pump, Geary-Jennings Sampler, Acid-proof Sump Pump, Geary Reagent Feeder, Laboratory AGITAIR® Flotation Machine, Laboratory Pressure Filter, Laboratory Ball Mill, Rubber Lined and Covered Products, Plastic Fabrication.**

## Books

*(Continued from page 826)*

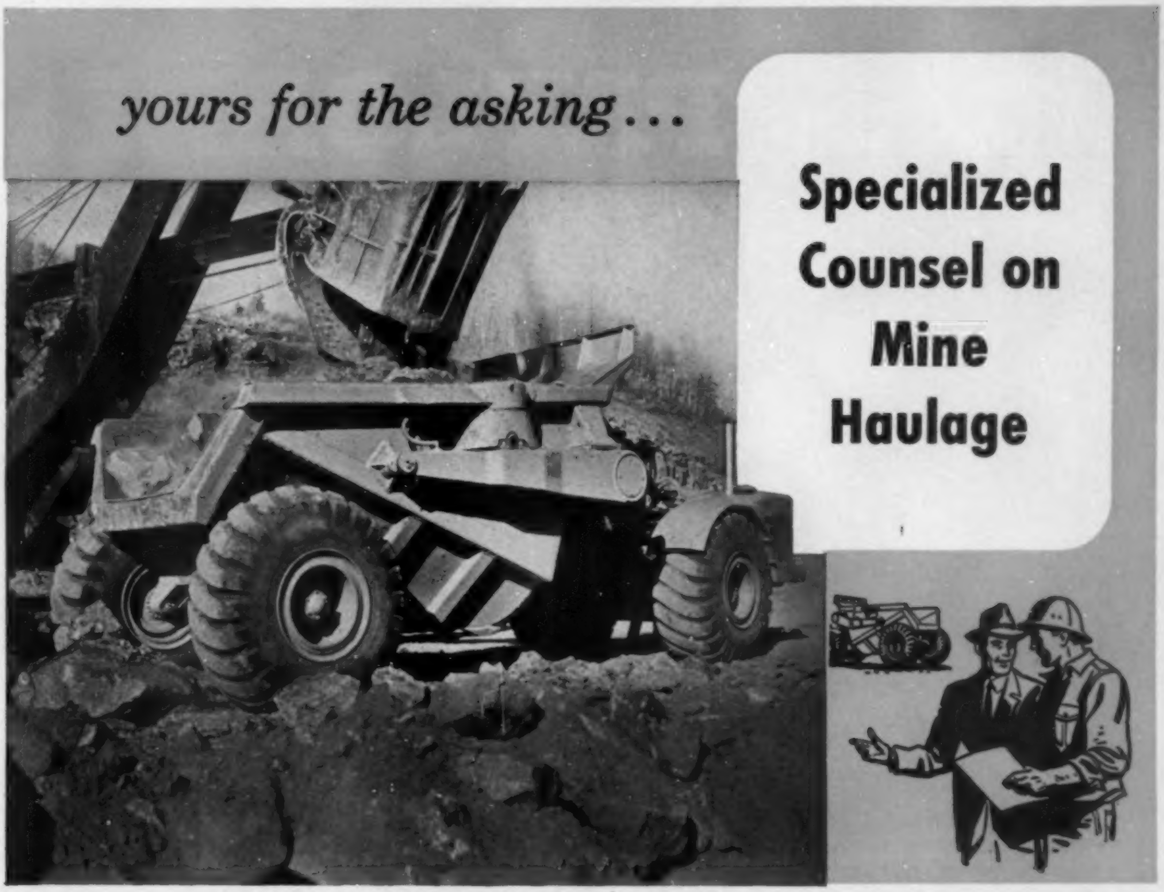
over 3000 pp., $12.00, 1957.—This volume is a complete reference of the sciences: chemistry, physics, and mathematics, that is continuously revised and annually published. This 38th edition is divided into five indexed sections consisting of mathematical tables, properties and physical constants, general chemical tables, heat and hygrometry, and quantities and units. It gives interpretations of factual data of major importance to scientific work and study. Over 100 pp. of new information have ben added to this edition. •

**Mines and Mineral Deposits, Missoula and Ravalli Counties, Montana,** Uuno M. Sahinen, *Montana Bureau of Mines and Geology*, Room 203-B, Main Hall, Montana School of Mines, Butte, Mont., $1.00, 1957.—The bulletin is replete with maps, charts, and diagrams; it outlines the geology and history of mineral production in some detail. Brief descriptions are given of individual mining properties in the counties.

**ASTM Standards on Cement,** published by the *American Society for Testing Materials*, 1916 Race St., Philadelphia 3, Pa., 264 pp., $3.00, 1957.—A compilation of all the ASTM standards pertaining to cement, substantially revised since publication of the previous edition in 1955. In addition to specifications and tests, the publication contains appendices giving information on balances and weights, a manual of cement testing, selected references on Portland cement, and other data. •

**American Civil Engineering Practice,** Vol. III, by Abbett-0015, *John Wiley and Sons Inc.*, $25.00, 1957.—This volume deals principally with structures of masonry, construction, and structural details of bridges and buildings. •

**The Southwest Resources Handbook,** ed. by Robert Boyd Ladd, *Southwest Research Center*, 8500 Culebra Rd., San Antonio, Texas, subscriptions: $250 for first year, $100 per year thereafter, 1957.—The Handbook will supply comprehensive data on the resources of Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, Texas, and Mexico. The initial publication, just published, will include information on the special character of the Southwest: physical setting and native animal life, human resources, water, energy resources and mineral fuels, other minerals and mining, soils and native vegetation, agriculture, manufacturing, and construction. The initial Handbook volumes, as well as continuing information as it is available, will be supplied to the subscribers to the service.

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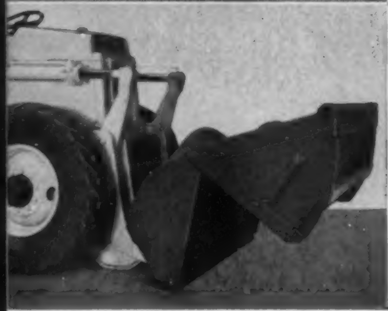
With slight clam lip opening you have a carry-all scraper that heap-loads itself, carries and spreads thin layers or dumps completely. Strips sod and grades with real accuracy.



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Open the clam lip full, and you have a sturdy bulldozer with hydraulic finger-tip blade-pitch control to regulate dozing depth and to discharge sticky material.

# help you handle more jobs

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14

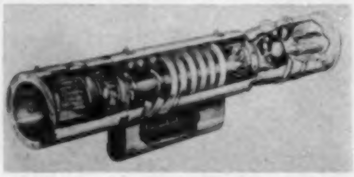
# Manufacturers News

News
Equipment
Catalogs

• FILL OUT THE CARD FOR MORE INFORMATION •

### Dust Collector

A new wet, inertial type Microdyne dust collector by *Joy Mfg. Co.*, although ten to 20 times smaller than comparable units, claims efficiency of more than 99 pct in collecting particles of 5 $\mu$ or bigger. Entering the unit at its mixer section, dust is enveloped in water as it passes through a fine spray. Air and watered dust then pass through turning vanes which impart a helical motion.



Centrifugal force dynamically separates the entrained particles and these are captured at the periphery of the eliminator section in blind louvres connected to a disposal sump below. The Microdyne can be mounted in existing duct work at the point of use. If necessary, pressure to move air or gases can be supplemented by a vaneaxial fan at the rear of the unit. **Circle No. 1.**

### Off-Road Tire

A new logger excavator tire of nylon full-ply construction is offered by *Dunlop Tire & Rubber Corp.* specifically for strip mining and logging operations. Tread pattern features three deep continuous rolling ribs, notched for traction on uneven ground. Shoulder area is molded in a heavy lug pattern for traction on sand and soft ground. **Circle No. 2.**

### Permissible Photoflash

Camera hounds can now go underground with a new photoflash unit developed by the *Bureau of Mines* and labeled permissible. Safe in gassy coal mines, the unit fires standard flash bulbs with any cam-

era shutter switch. Here R. S. James, chief of the USBM Branch of Electrical-Mechanical Testing activates the unit by placing a moistened finger across the connector contacts. **Circle No. 3.**

### Probetector

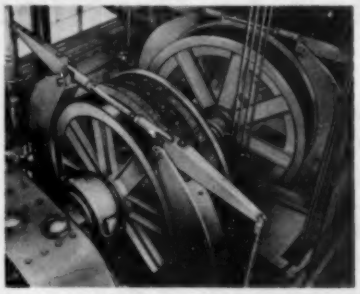
*Atlas Laboratories Inc.* has a portable instrument which registers concentrations of explosive gases on a direct reading meter. Factory calibrated for methane and ethane, the Model 504 Probetector operates on a 2v battery which is supplied with a charger. Metal case is weatherproofed. **Circle No. 4.**

### 40-Ton Payloads

A 600-hp diesel rear dumper built to carry a load of 40 tons is the latest offering by the *Autocar Div.* of White Motor Co., and the first truck to use more than 400 hp in a single engine. Equipped with a 27 cu yd body, the dumper has speeds up to 33 mph. Its Fuller transmission has nine forward speeds and two in reverse. **Circle No. 5.**

### Friction Hoists

ASEA friction drive mine hoists distributed by *Aros Electric Inc.* are the first in the U. S. to make use of several parallel ropes instead of the usual single one. Small diameter, narrow pulleys have less weight and reduce inertia. Compact size permits installation in headframe above shaft. **Circle No. 6.**



### Yellow Ventilation Tubing

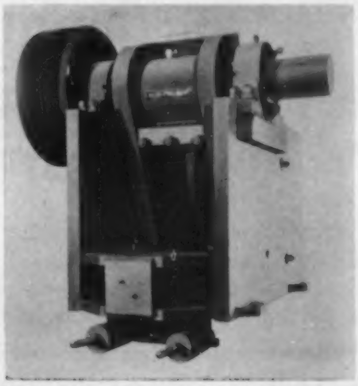
Distinct safety yellow color has been incorporated in the Nyprene Flexipipe mine ventilation tubing made by *Bemis Bro. Bag Co.* The new tubing is designed to give good visibility in the dimmest mine tunnels and to reduce the danger of tubing puncture by machinery and equipment. **Circle No. 7.**

### Air-Powered Hoist

Speeds vary from a creep to 10 fpm at full load in a new 4000-lb capacity hoist by Keller Tool Div., *Gardner-Denver Co.* Length of lift is 8 ft, weight is 100 lb, and hook-to-hook dimension is 23½ in. Fully mechanical brake prevents slippage. **Circle No. 8.**

### Single-Toggle Jaw Crusher

Designed for use where stone or ore is suitable for its single-toggle action, *Allis-Chalmers'* new Model ST jaw crusher has a capacity range between 180 and 360 tph. Featured are a single grooved flywheel and a crushing chamber which evens out



the load to decrease flywheel energy needs. ST weighs 61,000 lb and is now available in 30x42-in. and 42x54-in. sizes. **Circle No. 9.**

### Bulldozer

Stripping and coal handling operations will find use for the new No. 9U bulldozer by *Caterpillar Tractor Co.* Designed to retain large loads on long distance moves, the three-section blade is angled forward on its ends. Overall width of the attachment is 14 ft 10 in. **Circle No. 10.**

**(21) CENTRIFUGAL PUMPS:** *Ingersoll-Rand Co.* has a 16-page bulletin covering the Class GT centrifugal pumps. GT's are built in six basic sizes ranging in capacities from 100 to 3500 gpm, pressures to 450 psi, heads to 1100 ft, and temperatures to 300°F. Horizontal split permits complete accessibility of internal parts without disturbing suction and discharge piping. Form 7062-C supplies details.

**(22) PLATE FEEDERS:** McLanahan reciprocating plate feeders are detailed in a new 6-page technical bulletin from *McLanahan & Stone Corp.* Units are designed for feeding controlled quantities of materials, from sand to shovel-loaded rock and ore. Bulletin FRE-57 features on-the-job photos and specifications of both light and heavy-duty machines.

**(23) SPRAY NOZZLES:** Information on the Concenco water spray nozzles is contained in a new folder from the *Deister Concentrator Co.* Advantages claimed include definite alignment, leakproof connections, no clogging, quick removal and replacement.

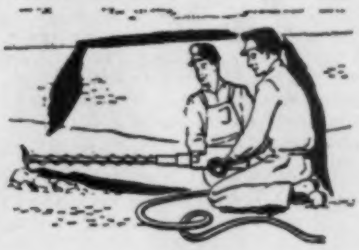
**(24) CARBURETED POWER UNITS:** Six new increased-horsepower 6-cyl carbureted power units are described in a 12-page catalog from the Construction Eqpt. Div. of *International Harvester Co.* Sizes range 68 to 133 hp. Units will operate on gasoline, LPG, or natural gas; and performance with each is detailed. Features are spotlighted with cutaway views.

**(25) ORLON FILTER FABRIC:** Filtration Fabrics Div., *Filtration Engineers Inc.* offers a data sheet on a filter fabric made of napped spun Orlon. It recommends the fabric for use with wet or dry equipment when small particle retention with a high rate of air or liquid flow is needed. Laboratory test data is included with a sample of the material, called Feon 408.

# Free Literature

**(26) CORE RACKS & TRAYS:** *Tomco Products* says their galvanized steel or aluminum drill core trays compare in price with field-made wooden units, and have the advantage of convenience and long life. Enameled steel angle racks are easily assembled; one capable of storing over 2500 ft of core can be put up in less than 15 min. Standard available trays are for 1, 1⅛, 1⅝, and 2¼-in. cores. Other sizes can be furnished.

**(27) COAL MINING TOOLS:** A 20-page catalog of Carboloy carbide coal mining tools from the Metallurgical Products Dept. of *General Electric Co.* also gives tips on reconditioning and grinding. Listings cover a complete line of machine, roof, auger, and finger bits.



**(28) CONVEYOR MATERIAL CONTROL:** Four-page Bulletin 550-P5 from *Builders-Providence Inc.* claims any belt-conveyed, dry material can be accurately, automatically, and continuously fed by the modified Conveyoflo meter. Described are design features, dimensions, typical applications.

**(29) Cb & Ta PRODUCTS:** A new booklet on columbium and tantalum products is offered to users of high temperature and abrasion-resistant alloys by *Shieldalloy Corp.* Properties and applications are described of the metals and their carbides and oxides.

**(30) DRIVE SPROCKET RIMS:** Durable, wear-resistant manganese steel replacement rims for drive sprockets of standard crawler tractors are described in new literature by Kensington Steel, div. of *Poor & Co.*

**(31) COPPER INDEX:** A new enlarged edition of "Copper & Copper-Alloy Specifications Index" is offered by *American Brass Co.* This seventh edition of Publication B-34 contains 28 pages.

**(32) DIAMOND DRILL BITS:** A new catalog with prices is offered by *Diamond Tool Research Co. Inc.*

**(33) TRACTORS:** Twelve pages of illustrated information on *Ford Motor Co.* tractors are available from the Tractor & Implement Div.

**(34) PUMPS FOR DRILLING:** *E. J. Longyear Co.* has a folder dealing with transmission and single speed pumping units used in diamond drilling. Drilling practices are outlined and advantages are given of transmission pumps in coring work.

**(35) GEOLOGICAL SURVEY MAPS:** The *U. S. Geological Survey* has state index maps showing all areas covered by Survey mapping, a folder describing topographic maps and symbols, and a price list of all special topographic and base maps published by the Survey so far.

**(36) DECO INDEX:** *Denver Eqpt. Co.* has an index of articles which appeared in Deco Trefoil in 1955 and 1956. Included is an index of technical bulletins published in this company magazine from 1938 to 1956. Bulletins are classified by minerals and companies featured.

## MAIL THIS CARD

**for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.**

8

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**(37) DUCTS & HOSE:** A tabbed booklet from *Flexhaust Co.* gives prices and information on Flexhaust hose and Portovent ducts. Products are used for moving air, dust, and materials via pressure, suction, or gravity.

**(38) TRUCK FACTS:** At latest count, there are more than 10,750,000 trucks on the streets and highways of the nation—nearly half of the world total. Last year the U. S. produced 45 pct of the world output. These and other facts on the ever-growing truck fleet are contained in the 1957 edition of "Motor Truck Facts," a biennial handbook of the *Automobile Mfrs. Assn.* The 59-page book presents the data in chart and graph form.

**(39) DIESEL CRAWLER:** A detailed cutaway view of the *Allis-Chalmers* HD-16 tractor is given in a new folder. Both the gear-type and hydraulic torque converter drive transmissions are shown in Form MS-1192.

**(40) METAL HOSE:** Seamless, corrugated, and interlocked flexible metal hose by *Universal Metal Hose Co.* is described in a new 10-page catalog. Universal assemblies are used to transfer liquids and solids in powder or granular form where flexibility with erosion and corrosion resistance is needed.

**(41) SMELTERS:** A 28-page booklet from *Mace Co.* details advantages of a line of smelters and accessory equipment. Smelting furnaces are efficient even in small sizes and feature low fuel consumption, good transportability, easy erection, cleaner slags, higher grade matte.

**(42) MINING IN ONTARIO:** A historical outline of the development of the mining industry in Ontario is offered by the *Ontario Department of Mines* in an illustrated 24-page booklet. This third edition includes developments up to the end of March, this year.

**(43) CENTRIFUGAL PANS:** *Knapp & Bates Ltd.* detail operation of their centrifugal pans for concentrating alluvial minerals in a new folder. Water consumption, feed rates, slurry density, concentration ratios are given. Operation detailed covers diamond recovery.

**(44) BIT RECONDITIONING:** *Kennametal Inc.* has a 20-page instruction and reference booklet, "The When and How of Reconditioning Kennametal Bits." Step-by-step photos accompany data on resharpening machine, auger, roof, rock, and core bits. A section is included on grinders, wheels, and wheel care.

**(45) WEATHER-PROTECTED MOTORS:** Features giving outdoor dependability to *Allis-Chalmers* FOD motors are detailed in a new brochure. Motors are rated 250 to 900 hp.

**(46) TANK & DUCT LINING:** *Dow Chemical Co.* has an 18-page illustrated booklet on the use of Saraloy 898 chemical resistant sheet lining for storage tanks, processing tanks, large pipes and fittings, fume ducts and hoods. Data is supplied on properties, uses, and installation of the flexible thermoplastic for corrosion protection.

**(47) SCRAPING COSTS:** Cutting earth-moving costs by using Cat Lowbowl scrapers is the theme of Form D717 from *Caterpillar Tractor Co.*

**(48) EARTHMOVING:** "Wanted: Hard Work," a new booklet from *Caterpillar Tractor Co.* shows Cat earth-moving equipment in on-the-spot operation.

**(49) INSTRUMENTATION & CONTROL:** A digest of specifications of instruments and controls made by the *Hays Corp.* is offered in a 12-page catalog. Sections detail pressure, flow, temperature, level, and gas analysis controllers.

**(50) GENERATING PLANTS:** *D. W. Onan & Sons Inc.* has revised its Blue Book of information on selecting electric generating plants. Covered are cost of operation and installation, evaluation of prime movers and cooling systems, history of plant development.

**(51) METHANE DETECTOR:** A 6-lb portable methane detector is described in a new bulletin from *Mine Safety Appliances Co.* Concentrations are indicated on an easy-to-read dial in either of two scale ranges.

**(52) PRODUCTS & SERVICES:** *Southwestern Engineering Co.* offers a 36-page brochure describing the products and services of their engineering, construction, and manufacturing firm.

**(53) SEISMIC DATA:** Descriptions of seisMAC, an all-electronic seismic data processing computer, and its related processing equipment are contained in a new 8-page brochure from *Texas Instruments Inc.* Bulletin S-318 gives details on seisMAC's automatic correcting for weathering, elevation, and normal moveout to minimize routine computations of seismic data.

**(54) GEARMOTORS:** *Westinghouse Electric Corp.* has an 8-page publication on gearmotors and package drives. Booklet DB-3650 details a large selection of types and sizes.

**(55) PLASTIC PIPE & FITTINGS:** Three grades of polyethylene pipe and a full line of high-impact styrene alloy fittings are detailed in a 16-page catalog from *Franklin Plastics Inc.* Instructions for installation are included with specifications.

**(56) SPECTROCHEMICAL ANALYSIS:** Design and use of excitation source units and discharge stands for spectrochemical analysis are described in a 24-page brochure by Hilger & Watts Ltd., available from *Jarrell-Ash Co.*

**(57) INDUSTRIAL NOISE:** Effects of industrial noise, recommended cures, and a new approach to solving the hearing loss problem are evaluated in an illustrated booklet from *Sigma Engineering Co.*

**(58) WET SCREENING:** Bulletin 2300 from *Dorr-Oliver Inc.* details the new DSM screen for wet screening of nonfibrous slurry feeds. Unit is designed for sizing in the 8 to 48 mesh range. Stainless steel screen is reversible for long life.

**(59) SELENIUM DETECTION:** Assembly and use of a kit for detecting the element selenium is described in a bulletin from the *U. S. Bureau of Mines.* Equipment and procedure are simple even for the layman. The publication is Report of Investigations 5328, "A Field Test for Selenium."

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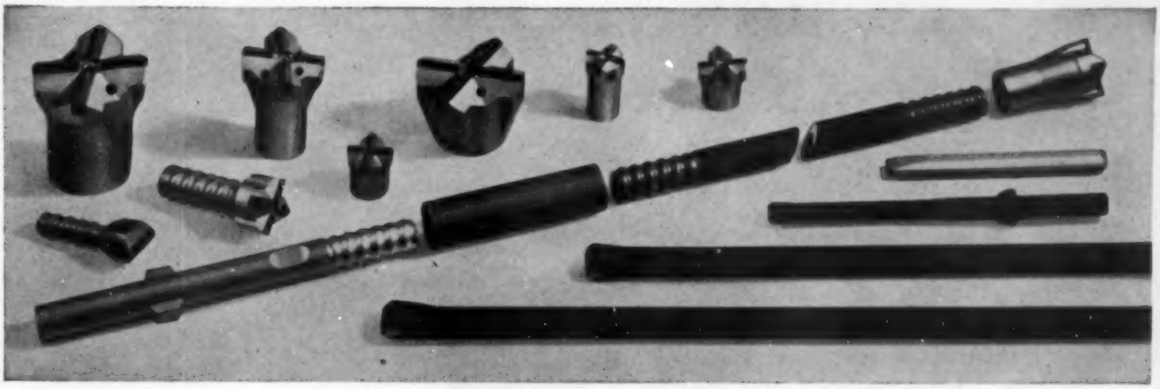


## New Iron Ore Project in Labrador

Newfoundland has passed legislation permitting development of low grade iron deposits in the Wabush Lake area of southwestern Labrador. Deposits there under concession of Canadian Javelin Ltd., are estimated at some 1.1 billion tons of hematite and magnetite. Work crews are now afield collecting data that may be used by a group of American and Canadian companies in developing the 2300-sq mile area. One of these, Pickands Mather & Co. of Cleveland has already made an agreement to lease and work a 5-sq mile section. No definite plans have been made for a beneficiation plant. Pickands Mather studies show that, to be economical, a concentrator would have to have annual capacity of 2.5 million tons.

## Canadian Fluorspar Producers At Standstill

St. Lawrence Corp., one of the three Canadian fluorspar producers, has suspended operations. Difficulties arose with the expiration of a contract with the U. S. Government six months ago, and an indefinite stoppage has been decided on despite help by the Newfoundland Government, including guarantee of a sizeable loan. St. Lawrence last year produced 73,000 tons of concentrate.

## Reopen Old Iron Mine to Work Low Grade

Abandoned since 1919 when its high grade ore was depleted, the Moose Mountain Iron Mine at Capreol, Ontario, is being reactivated with a concentrating plant to cost about $8 million. Located 35 miles north of Sudbury, the mine reportedly has 20 to 25 million tons of low grade ore. Production of concentrates should start next spring. Operations are directed by Lowphos Ore Ltd. for Hanna Coal Co., subsidiary of National Steel Corp.

## More Midnite Ore . . . Newmont Combines Laboratories

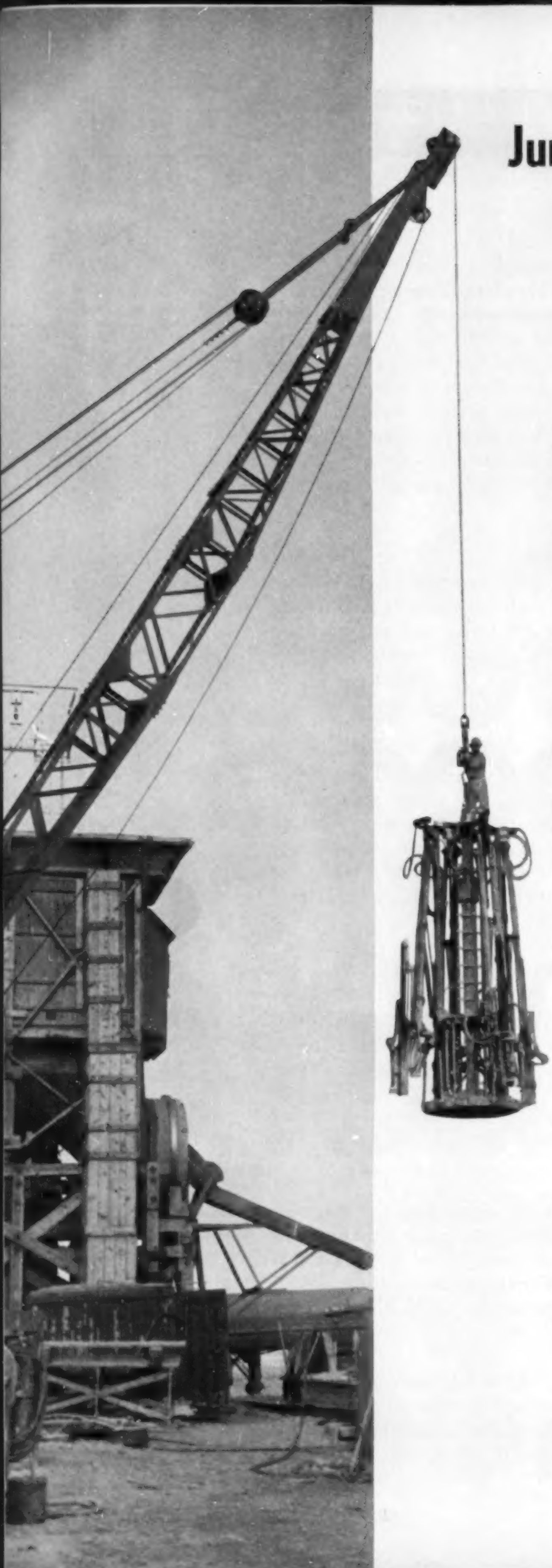
Discovery of two more orebodies at the Midnite uranium mine brings the total to 11. An estimate of $14 million in ore reserves has been labeled conservative. The mine in Spokane is operated by Dawn Mining Co. and controlled by Newmont Mining Corp. . . . Newmont Exploration Ltd., a Newmont subsidiary, has established a geophysical and metallurgical research laboratory near Danbury, Conn., combining two laboratories formerly at Jerome, Ariz., and Grass Valley, Calif.

## Cerro de Pasco Buys Another Fabricator

A manufacturer of copper and brass pipes and tubing, Lewin-Mathes Co. of St. Louis, was acquired by Cerro de Pasco Corp. on July 2. Other fabricating concerns recently purchased were Circle Wire & Cable Corp. in December 1955 and Fairmont Aluminum Co. in June 1956. A third of Cerro's gross assets are now represented by U. S. operations.

## Drilling Iron Property in High North

Ultra Shawkey Mines Ltd. has acquired the northernmost iron discovery in Canada. A drilling program is aimed at confirming a minimum of 250 million tons of ore on the south shore of Baffin Island. The claims consist of two deposits of mainly coarse to medium grain magnetite.



# Jumbo Sinks 18 Foot Diameter Shaft 10 Feet per Day!

## Le Roi multiple drill rig speeds Wyoming mine project

*"Only this Le Roi jumbo rig could make this kind of progress."* That's the opinion of experienced mining engineers at the site of a new mine shaft near Green River, Wyoming.

Their job was to drive an 18 foot diameter ventilating shaft 1600 feet straight down through hard Wyoming rock. They did it in record time with a Le Roi Shaft Jumbo.

Le Roi's Shaft Jumbo is a self-leveling multiple drill rig. It has four extendible arms, each mounting a heavy sinker drill on an independently controlled 2-to-1 air-feed shell. Each arm is mechanically positioned by air motors.

On the Wyoming job, each round in the hard formations required 65 holes drilled to an average depth of 12 feet. The drilling pattern included a row of holes spotted around the perimeter, with successive inner circles offset for maximum shattering and fragmentation.

Each complete drilling sequence was finished by the Jumbo in an average of 3 hours. By using the feed shells, instead of hand-held jackhammers, steel changing was eliminated. On a 65-hole round, 12 feet deep, time saved was considerable . . . and multiplied by the shaft depth, amounted to real money!

In addition, drilling was much more accurate using the positive feed, air-motor positioned drills. This meant more accurate patterns. Worker efficiency increased, too. Easily controlled feeding eliminated the big source of worker fatigue.

The Le Roi Shaft Jumbo can drill shafts from a minimum diameter of 11′-9″ up to a maximum diameter of 28′-0″, and shafts have been sunk with the Jumbo to a depth of 3,000 feet. Normally equipped with 4 drills, the Jumbo can be furnished with 2 or 6, if desired. It is also available with dust collectors. For complete information, contact your local Le Roi distributor, or write us direct.

**LE ROI** Division of Westinghouse Air Brake Co., Milwaukee 1, Wisconsin, manufacturers of Cleveland air tools, Tractair, portable and stationary air compressors, and heavy-duty industrial engines. Write us for information on any of these products.

# COUNTER-CURRENT DECANTATION

## at ALGOM URANIUM...

One of the largest yellow cake producers in North America, Algom Uranium Mines Ltd. has been operating their Quirke Mill at full capacity since early in 1957. A unique feature at this mill is the installation of ten Dorr Thickeners in the CCD washing circuit. The units are each 100 feet in diameter, constructed of stainless steel; and despite the severe climate, are located out of doors.

Situated in the Blind River Area of Ontario, the Quirke Mill uses Dorr-Oliver equipment and methods at many steps in the flowsheet. The steam visible in the photo is being vented through the roof from the completely enclosed Dorr-Oliver Uranium Leach Agitators installed in the mill building. Dorr HX Classifiers are also installed at Quirke along with a number of D-O pumps of various sizes and designs.

For more information on Dorr-Oliver's complete line of equipment for metallurgical processing, write for a copy of Bulletin No. 2200. Dorr-Oliver Incorporated, Stamford, Conn.

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# Black Lake Asbestos Open Pit Scheduled to Begin Operations Next Summer

**Half of overburden has been removed and construction of a $9.2 million mill is well advanced. Output will be 100,000 tons of asbestos fiber a year from 40-yr reserves.**

Lake Asbestos of Quebec Ltd., a subsidiary of American Smelting & Refining Co., which has been engineering the removal of overburden from an asbestos deposit lying beneath Black Lake in the Province of Quebec, has now succeeded in removing half the material required to prepare for mining operations that will begin next summer.

Work continues on schedule in developing an open pit and building a mill that will produce about 100,000 tons of asbestos fiber yearly—approximately a 10 pct addition to Canada's production and a 7 pct addition to free world supply.

For an earlier report on the $32.5 million undertaking, see MINING ENGINEERING, October 1956, p. 984.

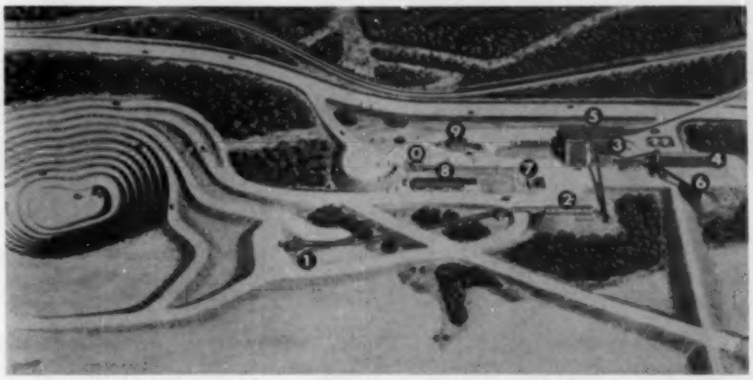
Black Lake, Quebec, where American Smelting & Refining Co. is spending $32.5 million to develop asbestos deposits in a project involving removal of 37 million cu yd of material, construction of four dams, rerouting of a river and highway, draining a lake, and provision for drainage of this populated area. On Black Lake, a dredge is pumping 50,000 gpm up on slopes to wash down soil overburden. Tailings piles from conventional asbestos mines in the area may be seen at top.

### Removal of Overburden

Readying the ore deposit for mining involves removal of about 37 million cu yd of overburden (of which some 30 million cu yd will be removed by dredging and pumping and 7 million by shovels and trucks) and draining the lake. At the time of production in 1958, engineers will have a precedent in submarine mining that may be applied to similar orebodies, long known but judged too difficult to develop. The Black Lake project, in fact, gained impetus from the success of draining and dredging operations to reach the iron ore of the Steep Rock area in Southern Ontario (see page 898).

Under an agreement with United Asbestos Corp. Ltd.—the Canadian company which holds mining rights to the deposit—Asarco is to: 1) develop the deposit; 2) equip the property with a mill to treat 4000 tpd of ore; 3) receive 75 pct of the proceeds until the capital investment is recovered, and thereafter split the proceeds according to a formula based on the grade of ore mined and milled; and 4) have complete freedom of operation during the life of the orebody.

*(Continued on page 848)*




Asbestos ore from Black Lake open pit will be transported by truck to primary crusher (1), and then carried by conveyors to wet rock storage pile (2) and dryers (3). From there, it will be conveyed to dry rock storage (4) and by underground conveyor to mill (5). Tailings will be conveyed to tailings pile by overhead conveyor (6). An electric substation (7), shop and garages (8), company offices (9), and change house (0), will be located as shown.

At left is a portion of Algom Uranium's Quirke mining and processing facility during construction in Canada's Blind River area. Both the Quirke and the Nordic mines and plants of Algom Uranium Mines Ltd. are now producing. Each is geared to process 3000 tpd of uranium ore, operating on a 24-hr basis.

*(Continued from page 845)*

**The Hydraulics Problem**

At Black Lake, suction dredging is employed in an asbestos operation for the first time, and a number of hydraulic difficulties have arisen. The area has an annual rainfall of 44 in. and it is fairly well populated so that the effect of alterations in drainage patterns on existing towns and other factors involving settled areas must be considered. Moreover, the material on the side of the lake is soft and must be carefully terraced to protect the mining pit from mud slides.

The tremendous quantity of material to be removed in readying the area for open pit mining is more than double that being taken out in the construction of the St. Lawrence Seaway, though the problems are quite different. Black Lake overburden is being removed by a giant 30-in. suction dredge which pumps mud and silt from the lake bottom, across the lake via pontoon pipeline and then 3 to 4 miles along a similar 30-in. steel pipeline on shore to disposal areas where the waste spills out at a rate of 500 gpm.

In a single spot the dredge can swing about 250 ft, cutting a bank 250x30x8 ft. Cutting time varies, from 40 min. to 1 hr, with density of the material. Average monthly rate is 1 million cu yd; and average composition of the waste is about 17 pct solids, so that about 50,000 gal pass through the pipeline each minute.

Although the 200-ton dredge was assembled from 11 sections on the site and, with auxiliary equipment, cost about $3 million, the cost of removing material by this method is about one-third that of mechanical removal.

The main mud and silt depository, designated *C* disposal area, is about 3 miles west of the lake. This area, with a maximum length of about 6700 ft and width of about 4700 ft, has a capacity of about 25 million cu yd. Two other disposal areas, *A* and *B*, are on the opposite sides of a diversion channel at the north end of the lake.

**Decantation**

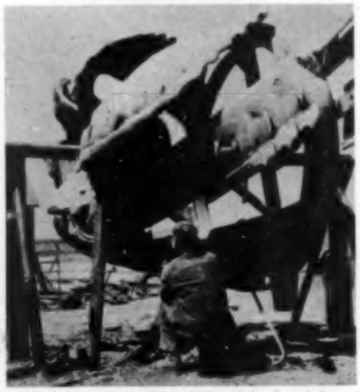
Decantation towers are located in these areas to carry the water from dumped mud and silt back to the lake via return ditches. Each tower has an open steel post frame that is gradually closed with timber stop-logs to a point above the settled mud as the level of the water rises. Water free of mud and silt continually flows in toward the tower from the pool where the dredge pipeline is discharging, and the water, being at a higher level than the barrier logs, flows into the tower and down two pipelines located at the bottom of the tower and running to the ditch.

When the bottom of the lake is lowered sufficiently to permit mining, the lake will be finally drained.

**Mining Operations**

Although dredging will continue until early 1959, the lake should be low enough in mid-1958 to allow

*(Continued on page 854)*



Welder repairs the 7-ft diam head for the dredge's 75-ft cutter used to dislodge mud and silt. The 8-ft long head has alloy steel teeth welded over its spiral cutting edge.

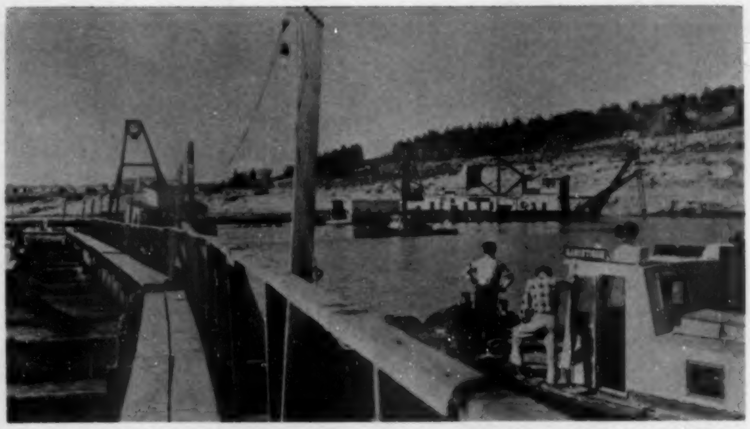
(Continued from page 848)

initial mining operations and tune-up operations in the mill. Open pit mining should be possible for about 20 years—after that underground methods will probably be necessary.

According to Asarco, ore reserves are now estimated at 47 million tons, and the mill will have a capacity of 5000 tpd. The stripping ratio will vary, but should average about three of waste to one of ore.

Since prevention from contamination is very important in asbestos mining and milling, the orebody must be carefully cleaned before initial operations are started.

Open pit operations will go down about 500 ft, and then may be extended another 500 ft by underground operations.



Here tugs ply their way near the dredge's pontoon pipeline while the dredge cuts into a bank. Barge behind dredge pays out 5-in. diam submarine cable which supplies power.

### Milling Operations

F. H. McGraw Co. of Canada Ltd., contractor, is well along with the work of constructing a \$9.2 million mill. Test work has shown that the ores will produce all grades of asbestos material.

Ore will be fed to a 48x60-in. primary jaw crusher and processed to —6-in. size before passing to trommel screens. These will separate the +4-in. ore, to be fed to secondary crushers, from smaller particles. Secondary crusher product, processed by a gyratory unit, will go to wet storage together with the smaller particles screened out after primary crushing. The rock will then be dried by cascading through a current of hot air. Now reduced to —3 in., the product will go to another gyratory crusher and be conveyed to dry storage. From this point on, the process will be one of air separation.

The mill, which is the main building at Black Lake, is 150 ft wide by 260 ft long (including the drier section) and 130 ft high.

Average price of the fiber produced is expected to be about \$130 per ton, yielding a gross annual revenue of \$13 million based on 100,000 ton production.

### New World Source

In developing the deposit, Lake Asbestos will be adding some 7 pct to the free world's asbestos supply. In 1953, according to the U. S. Bureau of Mines, world production, exclusive of Russia, totaled 1.375 million tons, of which 826,000 tons originated in Canada. In 1955, Canadian production was estimated to have approached 1 million tons.

In entering its new field, Asarco will continue its main company function as a raw materials supplier and will not make asbestos end products.

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Independent track reversal is especially advantageous in front-end loading. It permits this 105 to pivot sharply from the muck pile and get material into trucks faster. It gets either loader out of trouble quickly... a big factor on hazardous jobs.

A 105 operator is always "on top of his work". Without standing or "craning" his neck, he can see to attack the muck pile at the best spot for fast loading. This, combined with operating ease, greatly reduces fatigue... gets greater man-hour efficiency.

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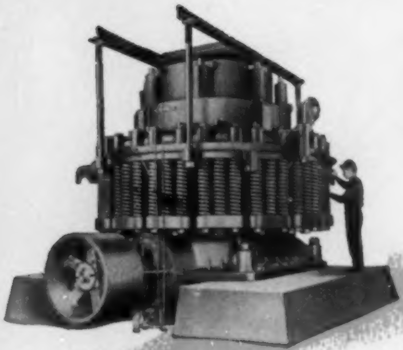

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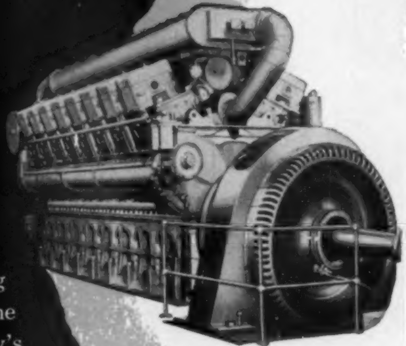

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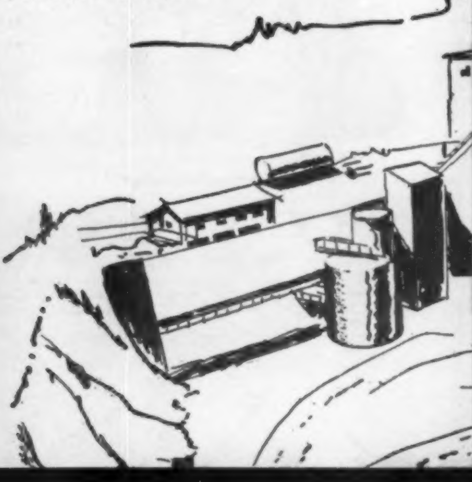

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A Traylor

BALL MILLS — ROTARY KILNS — PRIMARY GYRATORY CRUSHERS — APRON FEEDERS — JAW CRUSHERS — SECONDARY GYRATORY CRUSHERS

THAT hard rock man ministering to his pneumatic drill at right is one of the reasons why the Canadian economy is soaring like the tailings pile at a diamond mine. Printed in black ink and selling at five cents the copy, the postage stamp pictured honors an industry that accounts for 25 pct of Canada's foreign trade, commands one third of all the freight handled by its railways, and put more than $2 billion into Canada's overalls pocket in 1956.


To be issued on September 15, the stamp is a philatelic salute to mining as a "primary industry" of Canada. The date of issue also happily coincides with the arrival of delegates for the Sixth Commonwealth Mining & Metallurgical Congress which will open at Vancouver on September 8. The Canadian Institute of Mining & Metallurgy has invited more than 500 delegates for this 32-day meeting which will cover all Canadian mineral activities.

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THE spreading range of iron ore mining is reflected in the new name of the Lake Superior Iron Ore Assn. In deference to the increasing location shifts of iron sources, its members recently voted a name change to the American Iron Ore Assn.

While most domestic iron ore derived for many years from Lake Superior sites, the industry has extended itself over the last decade to many parts of the U. S. and Canada.

Among the companies which fill the membership of the organization are the following new names: Ford Motor Co., Iron Ore Co. of Canada, Oliver Iron Mining Div. of U. S. Steel Corp., Reserve Mining Co., and Steep Rock Iron Mines Ltd.

The association's statistics now reflect ore movements from these sources, and cover all iron ores produced and consumed within U. S. and Canadian borders.

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TRANSLATING data gained from seismic blasting into quickly read geological cross section charts is the function of a new device by Gulf Oil Corp. With the development, which combines two previous techniques—variable density recording and profile printing—Gulf gets photographs of underground domes and faults that are very much like geologic drawings of known areas. The resulting information is claimed the most accurate and detailed so far available from observation at the earth's surface.

Not long ago, in a West Texas oil area that had been prospected without a find, two strikes were made through the use of the device. It is believed that other areas formerly thought to be exhausted will be put to use through its application. The biggest field for the device will perhaps be in oil exploration where wildcatters will be able to decrease their unfavorable odds and old oil fields will sink more holes in the right places.

One advantage of the device is that it speeds up the accumulation of data considerably and frees technical manpower from the tedious work of interpretation. By a previous method it was first necessary to record vibrations as pen written lines; and not all of the raw data could be analyzed because of the time required for elaborate calculations. Only certain portions were studied, with the result that gaps were left in the cross section charts. Gulf's device on the other hand catches and records every seismic signal. Other companies are working on similar units and carefully watching developments.

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BEFORE the 18 months after July 1 of the present year have elapsed, our planet will have undergone its most complete physical inspection to date. In a coordinated effort, scientists the world over will explore the oceans, scan the skies and beyond, and probe the depths of the earth—all to obtain a more clear and unified picture of Earth's physical makeup.

The effort is the International Geophysical Year or IGY—the third such quest for the secrets of our environment. Altogether, 64 nations with variously complex research plans will participate. The U. S. will spend some $39 million, not including a special Defense Department project (costing almost $100 million) to launch the much-publicized earth satellite.

Of most direct importance to mining men will be the studious assault on the earth itself. Here, especially in the areas of seismology and geomagnetism, information may be uncovered that can lead to a better understanding of factors affecting geologic mapping and minerals exploration. In addition, the polar areas will be more thoroughly searched, partly to learn if mineral deposits underlie their vast stretches of ice. Attention will be directed also to such problems as the true age of the earth, the depth of its crust, its real shape, the characteristics of its molten core, and the phenomenon of earth tides.

Two projects preceded the present one. In 1883 the first International Polar Year was held and fifty years later another followed. Both were limited in scope to the areas of the high north and, even though very successful, research work was limited by the tools then available. The huge battery of equipment now at standby pushes the potential of IGY to such heights that significant discoveries are all but assured.

Most spectacular of the many projects scheduled for the 18-month "year" is the earth satellite. Un-

like the others, the satellite is a unique project and not an extension of already probed knowledge. But it is expected to be of value in known areas as well. If present plans are carried through, from six to 10 of the instrument-filled, mirror bright magnesium spheres will be launched during the IGY. Spotting stations, as yet uncompleted, will take fixes from various sites all over the globe and so make exact determinations of their location. From these points of reference corrections can be made to give us a precise map of the world.

Science's concentrated effort in the IGY will be worth many years of normal study and will have the added advantage of closely linking discoveries in highly specialized fields.

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SIMPLIFICATION of the spectrochemical determination of the elements in random samples of unknown matrix, or basic composition, has been achieved at the new U. S. Steel research center at Monroeville, Pa. The new method, called the carbon matrix technique, is also important for use when, as is often the case, samples are very small. Use of a graphite electrode and a known quantity of germanium provides both necessary dilution of the sample and a basis for spectral reference.

While the previous analysis method gave good results, the procedure was involved and often time-consuming. Calibrations depend on knowledge of the matrix of the substance to be analyzed, and usually sample material had to be mixed with substances that could be calibrated.

By the newly developed method, a small portion of sample material is placed in a depression drilled into the tip of a graphite electrode. When this is placed in the electrical discharge, the carbon of the electrode dilutes the sample sufficiently to make possible an approximate analysis since the emitted light depends less on the matrix of the sample for its intensity.

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SEVERAL weeks ago, Secretary of Interior F. A. Seaton reported that the ore potential turned up by 291 mineral exploration projects certified by the Defense Minerals Exploration Administration was worth an estimated $490 million. In comparison, about $8.5 million of Government funds had been put to use on these projects up to April 30, 1957.

Certification by DMEA, explains Administrator C. O. Mittendorf, means that a project shows ore deposits of sufficient quality and quantity to oblige the operator to pay a royalty on future production for repayment of the Government's exploration assistance.

Of the 1013 applications which had resulted in exploration contracts through the mentioned date, 765 have been terminated after some exploration work, 64 have been canceled without Federal expenditure, and 184 are still in force. DMEA had certified 269 of the 765 terminated projects, leaving 496 uncertified.

Federal expenditures on these 496 projects amounted to about $4.4 million, as compared with $7.1 million spent on the terminated projects which had been certified. Mr. Mittendorf pointed out that the relatively low amount spent in unsuccessful exploration work was an indication of DMEA's care in avoiding unwarranted expenditures.

The largest number of certifications relate to copper, lead, mica, tungsten, uranium, and zinc, he said. The greatest number of uncertified terminated projects also involved these commodities.

The cost of work now approved under DMEA contracts totals about $48.3 million, with the Government's share approximating $29.8 million. These are only estimated exploration costs, and not funds already expended.

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ADD another number to the list of artificially created elements. An international group of scientists at Sweden's Nobel Institute for Physics has bombarded curium with high energy Carbon-13 ions to produce Element 102. The new substance, designated Nobelium, is extremely unstable—it fritters its half life away in a mere 12 minutes, spewing alpha particles.

The research team included scientists from the Argonne National Laboratory at Lemont, Ill., the U. K. Atomic Energy Research Establishment at Harwell, and the Nobel Institute in Stockholm.

Indications that a new element had been discovered were first found a few days after work began in March. A set of experiments in April confirmed the first findings, and final confirmation came with a just-completed series.

Target material was a thin film of curium placed on an aluminum foil. This was placed near thin organic foils which were used as catchers for atoms that recoiled when the target was bombarded with particles from a cyclotron. The foils were dissolved in acetone on a platinum plate, which was flamed to give a thin source for pulse analysis. The platinum plate was treated with hydrochloric acid to put the activity in solution. This solution was then passed through a standardized ion exchange column. Alpha-hydroxyisobutyric acid was used to extract the new element from the column.

# "THIS D9 HAS DONE EVERYTHING WE HAVE TRIED IT ON YET!"

**V. D. Eachus, Eachus Equipment Rental Co., Las Vegas, Nevada**

This CAT* D9 Tractor with No. 9S Bulldozer is stripping overburden from gypsum in the Blue Diamond Corporation's operation, Blue Diamond, Nevada. The material is clay and rock. Says V. D. Eachus, owner of the unit: "This D9 has done everything we have tried it on yet. It is a big tractor and it does a big job. I have owned Caterpillar-built machines now for about fifteen years and find they stand up best on the toughest of work. Our dealer service is also tops."

That's typical of other reports about the Turbocharged D9. In every way, it's a big machine for your biggest, toughest jobs. It packs plenty of power — 260 HP at the drawbar and 320 HP at the flywheel. Its turbocharger, driven by the engine exhaust, packs air into the engine according to engine load, not engine speed, for greater efficiency. With bulldozer it weighs 35 tons, yet is as easy to maneuver as smaller machines, with hydraulic boosters providing power for steering, braking and master clutch use. And it's easy to service — for example, oil clutch, torque converter, transmission and steering clutches each can be moved individually.

To match your job needs, the D9 is available with torque converter or direct drive with oil clutch. For complete information, see your Caterpillar Dealer, who's a source of efficient service and parts you can trust. Ask him to show you facts and figures proving the D9 can step up your production. Better still, name the date — he'll be glad to demonstrate!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

**CATERPILLAR***



WANTED— THE HARD WORK

# Engineering Students and the Lure of Unionization

by Grover J. Holt, AIME President

OUR Student Members, as well as our young graduates, look up to you, members of AIME, as representatives of the engineering profession. You must not let them down.

To point this out, I am sure we have all heard rumors concerning possible unionization of engineers. This has now gone beyond the realm of possibility and may become a fact unless we are willing to do something about it.

I have received a copy of a letter sent to the Student Chapter of the University of Utah, wherein a group of engineers and technical men working in the Boeing factory at Seattle wrote to not only this Student Chapter but perhaps to all of the others in the country. On this page is the text of this letter.

You may draw your own conclusions as to whether you would classify this letter as a first step attempt to promote unionization, or merely a tender of uncalled for assistance to our Student Chapters. I would like to point out that this Seattle organization has no connection with the National Society of Professional Engineers.

I believe the only way to offset such propaganda is to make available to the younger element more activities in organizations such as the Institute. Our students are not naturally inclined towards unionization but unless something is done, such a swing might become inevitable.

It will be necessary for all of the organizations of engineers throughout the country to concentrate their efforts as a group to point out to students that there are advantages in professionalism rather than unionism. Our school faculties can go far but they must have help.

As an example of the activities being carried on in AIME to combat such agitation, each year the Arizona Section, at its annual meeting, holds a special session participated in by students, faculty, and the leaders in industry throughout their area. Some of the other local sections no doubt follow the same pattern, and it is evident the students do appreciate meeting with the heads of industry and have a feeling of being honored by their presence.

We should expand this sort of activity to make the students feel their ultimate employers are interested in their welfare, rather than leave them to their own resources entirely, with the feeling that industry is not particularly interested in what happens to them.

### Another Problem On-the-Job

I have, and I know most of you have, talked to these boys and find their feeling is that they are eventually headed for a part in management. On entering the industrial field, however, they suddenly find themselves in an industry where everyone, including their boss, is apt to be so busy with his own problems he all too frequently forgets that the younger element needs and appreciates guidance on his job.

In general, these young graduates do not expect to be pampered nor do they expect to become a vice president next year; however, the more they know about the operation of the particular company by whom they are employed, the more they feel they are on management's side.

### Role of the AIME Member

I am sure we all recognize the value of Boy Scout work, and the activities of Junior Achievement groups through the high school stage, and yet I wonder if we go as far in pondering the problems of our student members and the young engineering graduates entering industry.

The major portion of our industrial organizations today have programs covering various means of indoctrination, looking forward to the day when the engineer will become a part of company management.

I would like to see each and every one of you, through AIME, take the lead in sponsoring such activities as will make the young engineer feel he is on the management team, and I feel that the effort will be paid back through sorely needed increased enrollment in our engineering colleges and eventually in the form of dividends to the industry which promotes these ideas. Please remember these young engineers have friends in high school who may become interested in engineering. We need them badly. Unless we wish to face a slowdown in the race for technological developments and play second fiddle to Russia, we must produce more engineers.

In assisting with the solving of the problems faced by our students and young graduates alone, there is ample justification for your membership in AIME.

*Dear Student Chapter Chairman:*

Our association has placed you on the complimentary mailing list for our publication, the Northwest Professional Engineers. It is our belief you will find the material contained in this magazine to be useful to you in your capacity as chairman of a Student Chapter of one of the major Engineering Societies. Among other things, you will find that this publication is one of the few sources which provide significant factual data on engineers salaries.

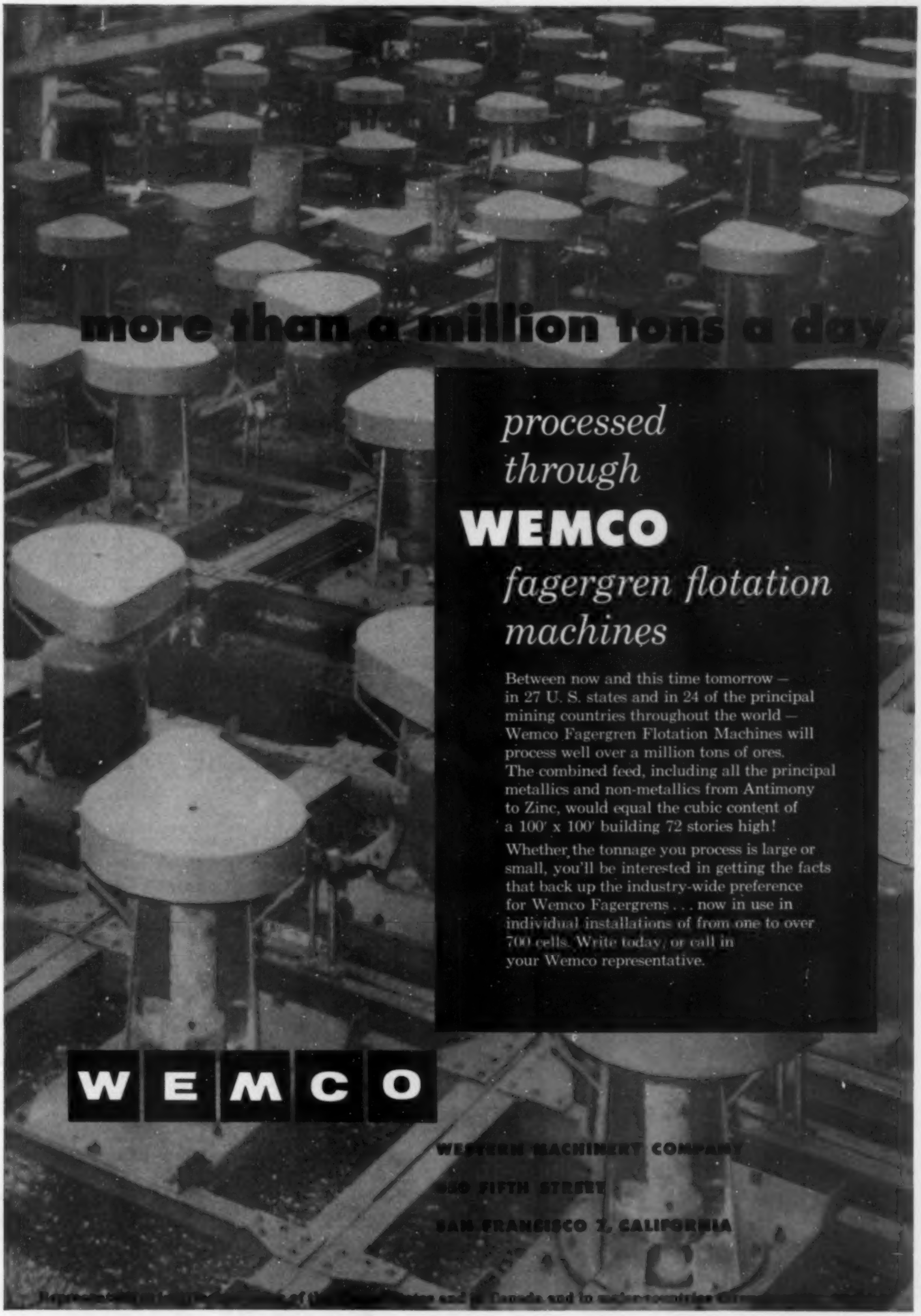
Our Association is the certified representative of 5,250 non-supervisory professional engineers employed by the Boeing Airplane Company in its Seattle and Renton plants. Since we are the certified representative, we have access to full and complete data—we choose to receive these data anonymously—for all engineers we represent. This permits us to perform statistical studies which are generally not available to any engineers not so represented.

SPEEA is an independent association which was formed in 1944 to advance the interests of professional engineers. We are not affiliated in any way with any local or national labor union. We are, however, affiliated with the Engineers and Scientists of America.

If you have any questions which you think I might be able to answer, or if you desire any information which you think I might be able to supply, I would be very happy to correspond with you.

Sincerely,

*Dan M. Hendricks, Jr.*, President
Seattle Professional Engineering
Employees Association."



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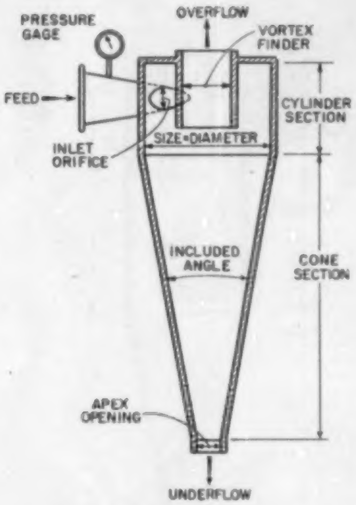
## SYMPOSIUM

### CYCLONES




Cyclone Nomenclature

# Development of the Hydrocyclone

by Stephen E. Erickson

MORE and more hydrocyclones are being installed in beneficiation plants. This recent rapid increase is of special interest in the history of beneficiation, since development of the hydrocyclone appears to have swung in a circle.

To avoid any chance of confusion, it would be well first to review the accepted definitions. The size of a cyclone is expressed as the diameter of the cylindrical section. Size of the inlet orifice—which may be circular, square, or rectangular—is expressed as a diameter, or as width and length, or as an area (in square inches). The angle of a cyclone is expressed as the total included angle. The overflow or finest classification fraction leaves the cyclone through the vortex finder. The underflow or coarsest classification fraction leaves through the apex opening.

**S. E. ERICKSON is a Beneficiation Engineer with the M. A. Hanna Co., Hibbing, Minn.**

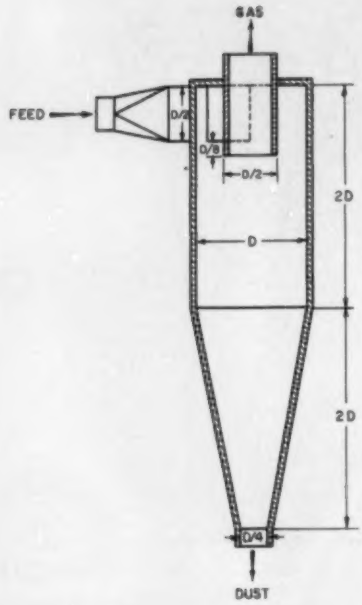
Although the position shown in the accompanying sketch is considered to be the normal one, it is sometimes more convenient in plant design to turn the cyclone on its side. In this case the coarsest fraction still comes from the apex opening and the finest classification still comes from the vortex finder.

Cyclones of the earliest type, used for dust collection, were actually solid-fluid cyclones in which the fluid was, of course, air or a gas. The illustration taken from the *Chemical Engineers Handbook* edited by J. H. Perry shows that the relative dimensions of dust collectors had already become well established. It is of particular interest to note that the shape and details are almost identical to those of the hydrocyclone. As early as 1885, according to S. J. Pascuel of Buell Engineering Co. Inc., designers knew the broad principle of collecting dust by introducing the dust-laden gases tangentially at the periphery of a circular container, allowing the

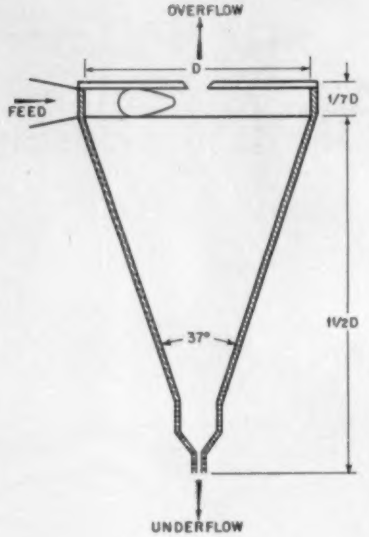
### THE SYMPOSIUM:

Originally presented under the auspicies of the Mineral Beneficiation Division at the 1957 AIME Annual Meeting in New Orleans, the five papers presented on this and the following pages represent an unusually well balanced picture of one of the fastest moving developments in beneficiation.

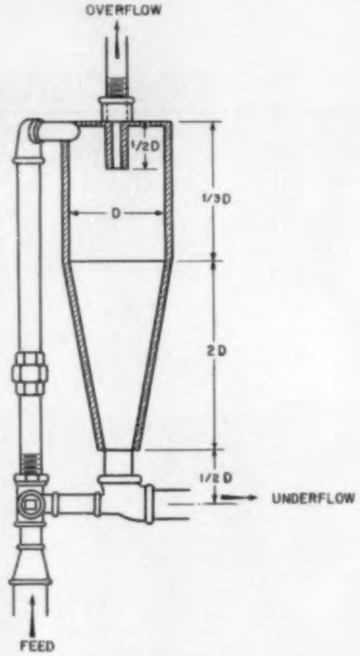
Under the chairmanship of R. H. Lowe and F. D. DeVaney the session outlined the history of the development, presented the factors in hydrocyclone selection, provided a tabulation of current operating data developed from a questionaire, and in the final two papers highlighted current practice in two key areas: Minnesota and Arizona.




**Dust Collector Cyclone**




**Driessen Cyclone**




**Humphrey Centrifuge**

dust particles to move toward the outer edge of the container by centrifugal force, and then separating the dirty fraction by means of openings or slots at the periphery. At that time at least two groups in the country were developing dust collectors of this type. John M. Finch, who was connected with the Knickerbocker Co. of Jackson, Mich., patented one of his constructions Sept. 1, 1885 (U. S. Patent 325,521) and application for Morse's patent of Sept. 13, 1887 (U. S. Patent 370,020), belonging to this same company, was originally filed June 9, 1886. Another company working on the problem at the same time was the Allington & Curtis Mfg. Co. of Saginaw, Mich., which owned a number of patents. An early example is the Allington & Curtis U. S. Patent 389,786 of Sept. 18, 1888, for which application was filed Oct. 5, 1886. The centrifugal dust separator was also being developed in Europe at this time.

In 1951 a retired mining engineer told the writer that he had observed a hydrocyclone in operation in 1914 at the Federal Chemical Co. plant in Tennessee. This was said to be a large diameter (4 or 5 ft) wet cyclone that was being used for desliming or classifying a phosphate rock pulp. Details of this plant were closely guarded by the company, and no published references to it can be found.

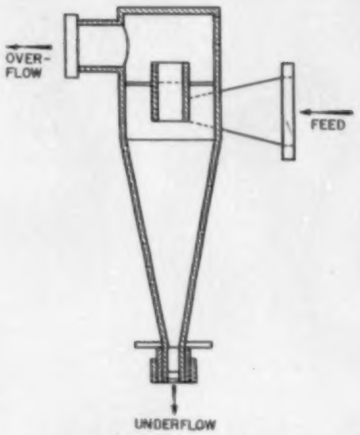
The earliest reference to a hydrocyclone for thickening and classification of liquid-solid slurries was published by M. G. Driessen in the May 1939 issue of *Revue Universelle des Mines* (Liege, Belgium) under the title "A New Process in the Washing of Coal." The article described sink-float separation of coal by use of a loess suspension. The cyclone was used to thicken the loess suspension in order to secure the desired separating gravity. This Driessen cyclone is interesting for a number of reasons. It had a relatively short cylindrical section but, of even more importance, the overflow went through a knife-edged opening and no vortex finder was used. The underflow was also constricted by passing through a cylinder and a cone. In this design the bottom conical section was replaceable so that the apex opening could be changed.

In passing, it should be mentioned that Driessen's paper was in French and was not translated into English. For this reason, and others, it received scant notice in this country. Driessen also described his cyclone in articles published in the British *Journal of the Institute of Fuel* in August 1939 and December 1945.

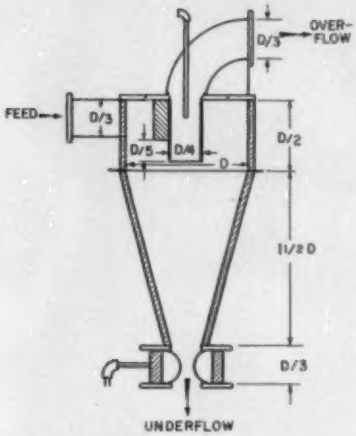
The next hydrocyclone to be described in the literature was the so-called Humphrey centrifuge, first shown in a Humphrey's Investment Co. drawing dated June 20, 1944. This device was used in batch spiral testing for thickening and desliming the recirculated pulp so that the overflow could be used for spiral wash water and the underflow for spiral feed. This was necessary to keep conditions more or less constant during a batch spiral test. The vortex finder in this centrifuge was threaded, and the desired separation was obtained by changing the relative length of the vortex finder in the vessel and by regulating the flow through the vessel with the three-way valve.

It is interesting to note here that although a number of batch testing spiral units containing a centrifuge were made and used in various laboratories, no one seemed to realize the potential plant applications for desliming, classification, and thickening.

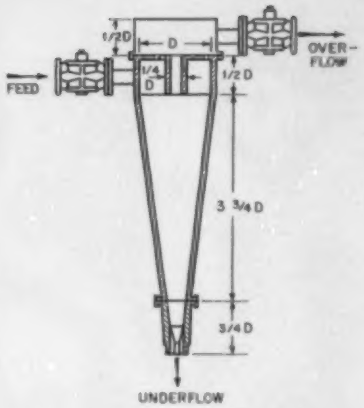
The Dutch State Mines cyclone, introduced in 1948, was the first hydrocyclone to become well known in the U. S. This is a development of the Driessen cyclone, as Driessen was chief of the Dutch State Mines research and testing laboratory. An important point regarding this design is that a vortex finder was used.




**Dutch State Mines Cyclone**




**Dorrclone**




**Heyl & Patterson Cyclone**

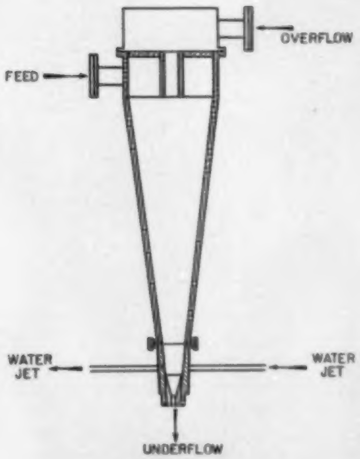
Operation was controlled by a rubber apex valve, a length of soft rubber tubing held in a screwed fitting. The apex opening was adjusted by varying the amount of squeeze applied to the rubber. An earlier Driessen adjustable apex had consisted of a motor-driven disk with openings of various size which were placed in position over the cone apex opening by means of the motor. The motor was controlled by a density measuring device.

The Dutch State Mines cyclone was taken over by the Dorr Co., which developed the Dorrclone. An early model is illustrated. In this design control was obtained by measuring the pressure inside the vortex finder with a centrally located pipe probe. From this measurement, air pressure was regulated in a rubber doughnut-shaped apex valve. Air pressure in this rubber part expanded or contracted the apex opening, changing the operating conditions within the cyclone. In the more recent Dorrclone models this automatic control has been eliminated and solid rubber apex inserts are used.

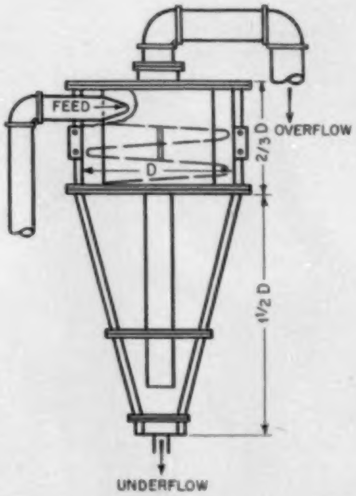
The Dorrclone appears to be the first hydroclone with a rectangular feed orifice.

About this time Driessen left Holland and came to America as consulitng engineer for Heyl & Patterson Inc. This company then put on the market a cyclone with replaceable rubber inserts to adjust the size of the apex opening. Separation was controlled chiefly by a valve on the cyclone overflow chamber. One interesting development made by this organization was a system of operating a number of small cyclones from a common manifold structure.

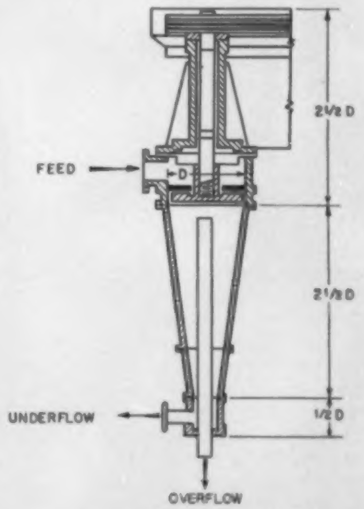
The Centriclone, marketed by Oliver United Filters Inc., differs from the other types of hydroclones. At the top of the Centriclone there is a motor-driven impeller that revolves at high speed. The feed slurry enters the device by gravity and passes over a stationary entry plate and into the impeller, where the required velocity is obtained. The centrifugal forces created throw the coarse solids to the outside, where they spiral downward and pass out of the side opening in the apex collar.



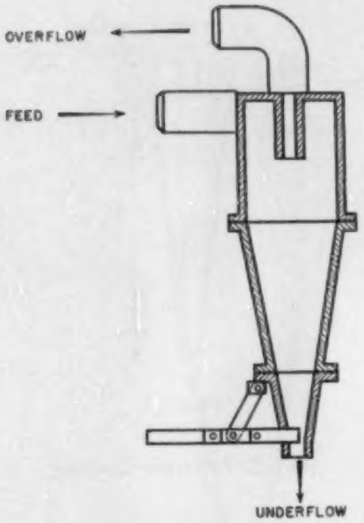

**Centriclone**



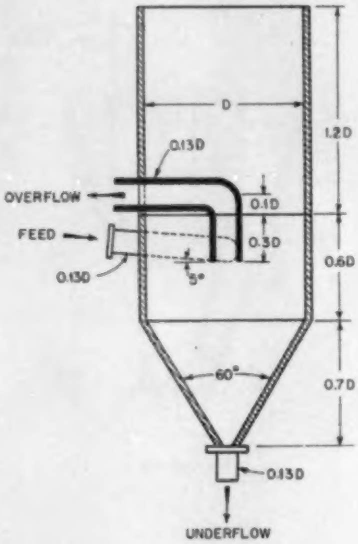

**Whirlcone**



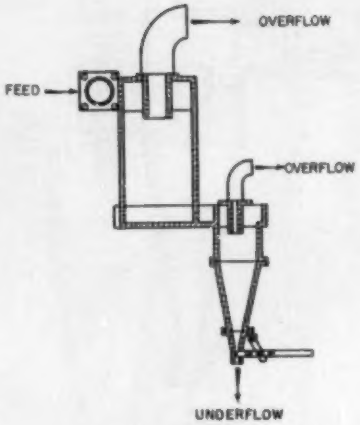

**Jet Injection Cyclone**




**Krebbs One-stage Cyclone**




**Open-top Cyclone**




**Krebbs Two-stage Cyclone**

The slimes and fines spiral upward in the core and are drawn off through an overflow riser pipe that leads the overflow downward through the apex. The upper opening in the overflow riser pipe is in the same position as the vortex finder in a conventional cyclone.

The Centriclone is no longer on the market. Its principal problem was excessive wear on the mechanical parts that operated in the slurry. On a 20-in. machine the impeller operated at 500 to 1200 rpm and consumed 10 to 30 hp, but rated capacity was only 100 to 300 gpm.

Another interesting type of cyclone is the Whirlcone, developed by Cottrell Engineering Co. Pulp feed is pumped tangentially into a spiral chamber in the top cylindrical section. The separation obtained in this device is controlled by a molasses gate or pinch valve on the apex discharge and by vertical adjustment of the vortex finder, which can be extended nearly to the cone walls at the bottom of the Whirlcone. A 20-in. Whirlcone has a 3½-in. feed inlet and a 4-in. vortex finder at 450 gpm of feed pulp at a pressure of 18 psi. The Whirlcone is used chiefly for sand and gravel preparation.

A number of proposals have been made for increasing the sharpness of separation obtained in a cyclone by adding hydraulic water near the apex to wash entrained slimes out of the coarse underflow product. One type of hydraulic cyclone is a jet injection cyclone marketed by Heyl & Patterson. In general it would appear that the benefit obtained by adding hydraulic water is small in proportion to the quantity of water that must be added.

The cylinder section of a cyclone designed by D. A. Dahlstrom is entirely open at the top and the vortex finder consists only of a centrally located pipe that conducts the overflow to the side of the vessel. The important point about this open top cyclone is that it operates at very low pressures. Maximum inlet pressure for a 30-in. cyclone is only 28 in. of water. This device is particularly adapted to making separations in a much coarser range than a conventional pressurized cyclone. With the open top design it is possible to obtain separations of 60 to 150 mesh.

The Krebs one-stage cyclone is rubber-lined and the apex opening can be adjusted by means of a collet device operated by an external handle. In the Krebs two-stage cyclone, marketed by Equipment Engineers Inc., feed pulp enters the upper cylindrical section through a sweeping inlet nozzle. The finest slimes overflow the cylinder through a vortex finder. The partly deslimed pulp then flows into a conical cyclone through an integral feed section. A secondary overflow containing additional slime is then removed through a vortex finder in the cone and the underflow is thickened and discharged through the apex. As with the one-stage cyclone, the rubber apex opening can be adjusted by a collet device.

### Summary

After a number of variations and modifications, presently accepted models of the hydrocyclone are again like the standard dust collector cyclones.

Prior to 1948 there was little or no interest in hydrocyclones. Since then more than 100 articles on the subject have been published. (Most of these are noted in the *Bibliography of the Liquid-Solid Cyclone* prepared by O. F. Tangel and R. J. Brison of Battelle Memorial Institute.) In view of the intense interest in hydrocyclones in the past eight years, there are several questions to be answered:

Dust collector cyclones were in common use for many years and the principles were well worked out. Many were used in everyday circumstances—in woodworking concerns to remove shavings and sawdust and in feed and flour mills. Why did it take more than 50 years to apply these principles to wet slurries?

After the first hydrocyclones were described in the literature, why did it take almost ten more years for the principles to be accepted?

And, finally, how many other devices or principles that could be applied to minerals beneficiation are now being overlooked?

**SYMPOSIUM**

**CYCLONES**

# Selecting a Cyclone for Wet Classification

by E. C Herkenhoff

THIS subject may be controversial. Personal preferences influence the final selection of cyclones, and side issues such as costs, floor areas, head room, and ease of replacing worn parts all enter the picture, but the following comments and data should apply to most cyclone selection problems.

Broadly, the uses for cyclones in wet classification may be divided into three fields:

1) *Open circuit* operation, for two products, in which feed rate and sizing vary and the products vary. For example, feed may be divided into a sand product and a slime product.

2) *Open circuit* operation, for two products, in which feed varies, one product to have constant sizing. This calls for adjustment in either the apex or the vortex aperture.

3) *Closed circuit* operation, the finished product to have constant sizing. Most classification jobs fall in this category.

Under each case above the duty may be subdivided into four types:

Type A. *Coarse* separations, about 20 mesh maximum, to 200 or 325 mesh minimum.

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Type B. *Fine* separations, classed as *desliming*, from 200 to 325 mesh maximum to 5 $\mu$ minimum.

Type C. *Desliming or desanding* separations wherein one product must be washed exceptionally clean by several stages of cycloning.

Type D. Combinations of *coarse* separations and *fine* separations using a coarse primary step followed by recycloning of the overflow for extremely fine separation.

Generally speaking, the following physical conditions govern the uses of cyclones for the above types of separations:

**A. Coarse Separations**

1) High pulp density of the feed slurry, to increase the density of the overflow product.

2) Low feed pressures, maximum 3 to 6 psi, to minimize centrifugal force.

3) Larger diameter cyclones with larger diameter vortex finders, to minimize the differential density between underflow and overflow.

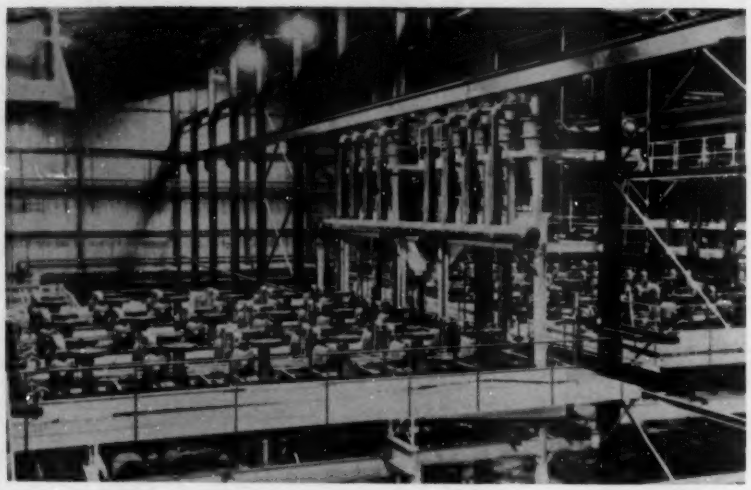
4) Shorter conical sections (wider included angles) to crowd coarser material into the inner vortex and minimize the distance between apex and vortex openings.

5) High density underflow product, to assist in crowding coarser particles into the inner rising column of pulp.

**Table I. Data Computed From Published Information On Cyclone Performance***

| Feed Pressure, Psi | Gallons Per Minute Per Square Inch of Inlet Area | | | Ratio of Inlet Nozzle Area (Square Inches) to: Cylinder Area, Sq In. | | | Vortex Area, Sq In. | | | Vortex Circumference, In. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | High | Low | Average | High | Low | Average | High | Low | Average | High | Low | Average |
| 3 to 3.5 | 32 | 10 | 20 | 46 | 7.1 | 23 | 5.4 | 1.1 | 2.9 | 1.75 | 0.44 | 1.08 |
| 4 to 4.5 | 136 | 8 | 50 | 46 | 5.2 | 17 | 4.0 | 0.43 | 2.0 | 1.50 | 0.32 | 0.78 |
| 5 to 7 | 53 | 17 | 35 | 60 | 6.9 | 32 | 2.9 | 0.77 | 2.0 | 1.95 | 0.51 | 1.18 |
| 8 to 10 | 55 | 24 | 38 | 26 | 14 | 20 | 3.3 | 1.60 | 2.1 | 1.80 | 0.80 | 1.34 |
| 11 to 14 | 40 | 26 | 31 | 24 | 13 | 16 | 3.3 | 1.40 | 2.3 | 0.90 | 0.33 | 0.50 |
| 15 | 76 | 29 | 51 | 60 | 15 | 30 | 2.9 | 1.00 | 1.7 | 1.95 | 0.52 | 1.09 |
| 30 to 35 | 76 | 74 | 75 | 40 | 25 | 37 | 2.3 | 1.00 | 1.6 | 3.00 | 2.00 | 2.50 |

* Taken from 25 typical tests, published in South African technical journals and AIME papers, for cyclones ranging from 10 to 30-in. diam.



The bank of cyclones visible in upper center of picture are in flowsheet ahead of the secondary rougher flotation circuit in the White Pine concentrator (MINING ENGINEERING, *May 1956, page 510.)*

**B. Fine Separations**

1) Low pulp density of the feed slurry to maintain a low density overflow product.

2) High feed pressures, 10 to 50 psi, to increase centrifugal force.

3) Smaller diameter cyclones with small vortex finders, to increase centrifugal force at a given feed pressure.

4) Longer cylindrical sections, to provide greater distance between the vortex finder and apex orifice.

5) Longer conical sections with narrower included angles, for greater retention time and more gradual change in horizontal vectors of force.

6) Low density underflows, to avoid crowding of particles into the inner rising vortex.

**C. Desanding-Desliming**

1) Low feed density, the high proportion of water in feed making a clean underflow.

2) Two-stage treatment of either product or both, repulping with additional water and recycloning.

3) Combination of cylinders and cones with recirculation of the secondary overflow from the cone.

4) Low density for the overflow; high density for the underflow.

**D. Combinations of Coarse and Fine Separations:**

Fine separations and desliming separations sometimes are made by removing the bulk of the solids under conditions of *coarse* separations, and then recycloning the overflows under conditions of fine or desliming separations.

**Conditions and Data Requirements:** Before a cyclone can be selected for a specific job, the following questions must be answered:

1) What is the tonnage rate of new feed to be treated, dry solids or pulp of what percent solids?

2) Is the duty for open circuit or closed circuit? What will the circulating load be?

3) What is the product of value—overflow or underflow?

4) What subsequent treatment will be given the desired product? (Flotation, sand leaching, filtration, slime agitation, magnetic separation, water circulation.) Stated another way, what is the relationship to the total process or succeeding steps? This is very important in evaluating possible applications for cyclones.

5) What mesh of separation is desired for the overflow and what mesh for the underflow? These mesh specifications should be carefully considered and evaluated with a view to achieving a different metallurgical result when subsequently processing the cyclone product.

6) What limitations of dilution or pulp density are there for the feed slurry, overflow, and underflow? Here it is axiomatic that if the feed slurry is not very low (5 to 10 pct solids) coarse separations in a single pass may not be possible. If full control of feed dilution can be provided, control of the mesh size split is greatly simplified.

7) What is the specific gravity, composition, shape, and size range of the feed particles? The maximum particle size, especially of possible occasional tramp or foreign matter, must be known. (Wood chips, clay balls, wire fragments, grinding media, tramp ore pieces).

8) What is the pulp viscosity, or nature of the suspension liquid? This is important in nonmineral applications or in the chemical field.

9) Is the pulp flocculated or dispersed? Are dispersants permissible?

10) What are the variations in volume of feed pulp? Is the feed coming from several units, some of which may often be closed down as a matter of overall plant control? Circulating load changes such as those cited in the article by DeVaney on taconites (page 880) must be taken into account.

11) If the gravity feed is obtainable, what is the maximum head? If pumps are available, what are the characteristics?

12) What control is desired—manual or automatic regulation of one or both products?

13) What are the temperatures of the pulp? Are hydrocarbon oils, acids, bases, or other chemical compounds present? (Affects selection of cyclone linings.

14) How does the cyclone compare with alternative means as to power consumption, space requirements, maintenance costs, and performance?

**Pilot or Full-Scale Testing:** When all data on operating conditions have been assembled, there are three possible courses of action: 1) The problem can be given to a manufacturer or supplier of cyclones. 2) If qualified personnel are available, a pilot or full-scale run can be made using cyclones designed and built by the company or purchased

At J&L Steel's Vesta coal washing plant more than 30 of these cyclones are installed. The 14-in. units were company designed and built. (MINING ENGINEERING, *December 1956, page 1208.*)

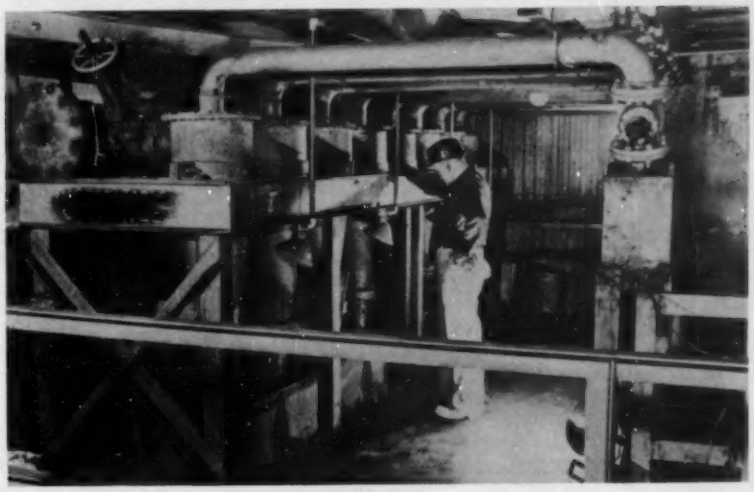


Table II. Capacity Ranges for Various Sizes of Cyclones

| Cyclone Cylindrical Diameter, In. | Cylindrical Area | Range of Feed Inlet Area, Sq In. | Range in Ratio of Inlet Area to Cylindrical Area, 1 to: | Feed Range, Gpm |
|---|---|---|---|---|
| 3 | 7.07 | 0.05 to 0.7 | 140 to 10 | 3 to 25 |
| 4 | 12.57 | 0.20 to 0.8 | 63 to 16 | 15 to 40 |
| 6 | 28.3 | 0.8 to 1.8 | 35 to 16 | 25 to 75 |
| 10 | 78.5 | 1.8 to 4.5 | 43 to 17 | 120 to 200 |
| 12 | 113 | 4 to 8 | 28 to 14 | 150 to 300 |
| 14 | 154 | 5 to 11 | 31 to 14 | 175 to 350 |
| 18 | 254 | 10 to 18 | 25 to 14 | 250 to 500 |
| 20 | 314 | 12 to 20 | 26 to 15 | 300 to 800 |
| 24 | 452 | 15 to 30 | 30 to 15 | 500 to 700 |
| 30 | 707 | 30 to 50 | 23 to 14 | 800 to 2000 |

from commercial suppliers. 3) The first and second procedures can be combined. This is the recommended action, as it obtains the best advice available and trains company personnel at the same time.

Usually selection of cyclones should be preceded by pilot runs in the plant or by batch tests using cyclones of about the *same size* contemplated for actual operations. It is best to avoid using very small cyclones and then extrapolating to larger units for the production plant. Batch tests, even with large cyclones, can be made at relatively low cost, and they yield valuable data.

At this point it is a good idea to have the company metallurgist take several months off to read some of the domestic and foreign technical articles on cyclones — it will take at least that much of his time! South Africa has used cyclones extensively, and it will be profitable to study South African publications, principally the *Journal of the Chemical, Metallurgical and Mining Society of South Africa*. The bibliography prepared by Tangel and Brison of Battelle Memorial Institute on the liquid-solid cyclone will be of great assistance.

The researcher will probably find the description of a problem similar to his which has been solved successfully by using certain cyclones under certain conditions. However, it cannot be too strongly stressed that cyclones are versatile pieces of equipment and can operate under an amazingly wide range of conditions and still do a passable job. Many applications described in the literature do not necessarily represent optimums and may have been adopted simply because someone else used that cyclone or because it was a home-made proposition.

**Multiple Vs Single Cyclones:** There appears to have been a trend, particularly in South Africa, to use a single large cyclone for a given job. As cyclones are relatively cheap to buy or build and lost operating time is costly, it is urged that serious thought be given to using multiple units of small cyclones rather a single large cyclone. Often the efficiency is greater and the ability to handle variations in feed volume is vastly better. Less head room is required and there is little or no loss in production when worn linings are being replaced or chokes cleared.

In a review [1] of recent developments in the uses of hydrocyclones[2] in mill operation, S. K. DeKok, one of South Africa's recognized authorities on wet cyclones, stated: "It should be noted that most of the work on the Rand has been carried out in what may be termed large cyclones in closed milling circuits. The wider applications . . . and the interesting results obtained in working with small units deserve further study."

**Selecting a Cyclone:** Selection of a single cyclone or multiple cyclones for a certain job starts with the gallonage of slurry to be treated. If solids tonnage only is given, then the pulp density of the feed slurry must be determined by tests or flowsheet requirements or by assumptions based on experience with related applications.

Cyclone capacity is a function of sizes of inlet nozzle, vortex finder, apex opening, and feed pressure. D. A. Dahlstrom has presented a cyclone capacity formula equating the diameters of the inlet nozzle, vortex finder, and cyclone energy loss in feet of fluid. It has been found, however, that the formula must be modified by a correction factor that may vary considerably.

It has been clearly demonstrated by D. F. Kellsall,[3] using a 3-in. diam cyclone, that there is an optimum size of feed inlet for a given cyclone. Under the conditions of his particular tests this optimum, which may be expressed as ratio of feed inlet area to cyclone area or to vortex finder area, has been calculated as 1 to 90 (cyclone area) and 1 to 0.64 (vortex finder area).

Careful analysis of published plant test data based upon using cyclones of 10, 12, 18, 20, 24, 27, and 30-in. diam will show that the concept of an optimum feed inlet diameter for a given cyclone has been largely ignored. This may be because cyclones can be made to operate under two basic conditions:

1) The *feed nozzle* is the principal restriction on throughput and the pressure drop occurs mostly between the pump side of the feed nozzle and the inside of the cyclone.

2) The *vortex finder* and to a lesser extent the *apex opening* are the principal restrictions on throughput, and the pressure drop occurs mostly between the outer wall of the cyclone and the open end of the overflow conduit.

Data in Table I, extracted from published articles, illustrate the high, low, and average figures for gallons of feed per square inch of inlet nozzle area and for ratios of inlet nozzle area to cyclone area, vortex finder area, and vortex finder circumference. These are given for feed pressures from 3 to 35 psi. Although there are some wide extremes between the high and low, average figures can be derived from Table I and may be used for general approximations:

| Feed Pressure, Psi | Gallons Per Minute Per Square Inch of Inlet Area | Ratio, Inlet Nozzle Area to: Cyclone Area | Vortex Area |
|---|---|---|---|
| 3 to 7 | 20 to 35 | 1 to 24 | 1 to 2.5 |
| 7 to 14 | 30 to 38 | 1 to 24 | 1 to 2.0 |
| 15 to 35 | 35 to 75 | 1 to 35 | 1 to 1.7 |

For most applications it is recommended that the average or lower limit of capacity per square inch of inlet nozzle area be taken because the literature indicates that optimum cyclone separations are made under such conditions.

Usually manufacturers of cyclones offer units in several diameters and each size may be provided with several feed inlet nozzles giving different inlet areas. Commonly, capacity ranges for cyclones of various size are as shown in Table II. For example, if the cyclone problem falls into a coarse separation category wherein an overflow at 35 mesh is desired, the operator should figure on using: low feed pressures, 3 to 6 psi; high pulp densities in the feed slurry, 55 to 65 pct solids; larger diameter cyclones, 18-in. diam or more; and larger diameter vortex finders.

If there are enough gallons of feed, several cyclones may be provided. If the amount is low, it may be necessary to use a single cyclone of smaller diameter than desired, or a relatively small feed nozzle in a larger cyclone.

As a second example, assume that the cyclone problem calls for a desliming type of operation making an overflow of about 15 $\mu$ maximum particle size. It will then be necessary to use: high feed pressures, 10 to 20 psi; low pulp densities of the feed slurry, below 30 pct solids; small diameter cyclones, 6 to 8 in. or less; and small vortex finders. Obviously, for an application such as this, it would not be good practice to use a single large cyclone. However, the bulk of the coarse solids might be removed by a large, low pressure cyclone, and the overflow product might be recycloned with small, high pressure cyclones. This scheme often saves power and results in less wear and higher efficiencies.

From the feed capacity basis, the size of the cyclone can be determined within rough limits. Refinements in capacity are then obtained by variations in the size of the vortex finder. This part is inexpensive and can be changed or replaced as required. Normally several sizes can be provided for any given cyclone. Sizes of apex opening also affect capacity, and when the approximate weight split is known, an apex valve can be selected that will handle the tonnage. Table III shows capacities of some types of apex valves.

In computing the weight split, it is highly important that the underflow density be accurately known and not assumed to be too high. If too small an apex opening is provided the feed capacity is not greatly affected but the particle size in the overflow increases sharply. With the average cyclone orifice proportions, it is never observed that a cyclone chokes at the vortex finder. The choke always comes at the apex, and under such conditions the entire feed stream continues to enter, but discharges from the vortex finder.

When cyclone and feed nozzle sizes have been selected and ranges have been determined for the vortex finder and apex valves, the installation can be made. To obtain steady separations at the desired point, exact sizes for the apex and vortex openings can be pinned down later.

At this point it should be observed that cyclones for heavy medium separations have substantially the same proportions as those used in wet classification, but generally are in the 10 to 14-in. diam size range. Such cyclones act somewhat as classifying cyclones, and the converse is true—some classifying cyclones may yield a heavy media effect by virtue of the feed solids acting as autogenous medium. This effect usually is not pronounced until the feed density is quite high and only when a high density underflow is maintained. Under such conditions it is not surprising to find some coarse lightweight gangue particles crowded into the overflow and a concentration of high density minerals in the underflow. This brings up a point treated in more detail in the article by Salter and King on page 883—the differential grinding effected in some circuits when the mill circuit is closed with cyclones. Although this subject is outside the scope of the present discussion, it should be kept in mind when the mesh of split desired is specified.

Table III. Capacities of Apex Valves

| Apex Diameter, In. | Area, Sq In. | Capacity Dry Tons Per Hour* |
|---|---|---|
| 5/8 | 0.31 | 2 to 4.5 |
| 3/4 | 0.44 | 4.5 to 8.5 |
| 1 | 0.85 | 8.5 to 12.0 |
| 1 1/4 | 1.23 | 9 to 17 |
| 1 5/8 | 2.07 | 15 to 29 |
| 2 | 3.14 | 22 to 44 |
| 2 1/4 | 3.98 | 28 to 56 |
| 2 1/2 | 4.91 | 35 to 70 |
| 2 3/4 | 5.94 | 42 to 84 |
| 3 | 7.07 | 50 to 100 |
| 3 1/2 | 9.62 | 100 |
| 4 | 12.52 | 130 |
| 4 1/2 | 15.90 | 165 |

* Equipment Engineers Inc.
** Densities of underflow range from 64 to 80 pct solids and specific gravities of dry solids from 2.6 to 4.2.


## Acknowledgments

The author gratefully acknowledges the information and assistance provided by Heyl & Patterson Inc., Equipment Engineers Inc., and Dorr-Oliver Corp.


## References


[1] S. K. DeKok: *Journal of the Chemical, Metallurgical and Mining Society of South Africa*, Feburary 1956.
[2] D. F. Kellsall: *Journal of the Chemical, Metallurgical and Mining Society of South Africa*, September 1955.




Table I. Operating Data

| Item | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|

# Compilation of Cyclone Operating Data

by T. M. Morris

THE following data have been compiled from information submitted by 24 plants in answer to a questionnaire sent to cyclone manufacturers and to companies using cyclones for wet classification, either for closed circuit grinding or for desliming.

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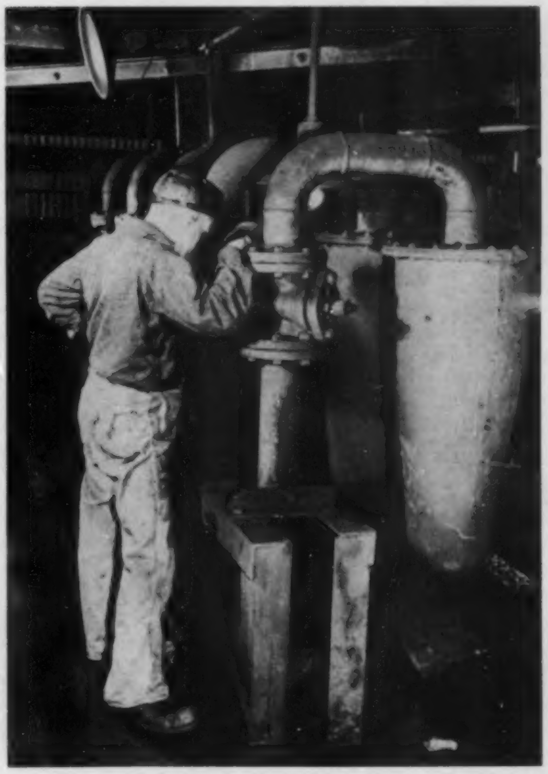
## Index I

| Code Number | Company |
|---|---|
| A | Atlas Consolidated Mining and Development Co. |
| B | White Pine Copper Co. |
| C | Tennessee Copper Co. |
| D | Banner Mining Co. |
| E | Idarado Mining Co. |
| F | National Lead Co., MacIntyre Development |
| G | Climax Molybdenum Co. |
| H | Homestake Mining Co. |
| I | Homestake Mining Co. |
| J | Nevada Scheelite Inc. |
| K | Cleveland-Cliffs Iron Co. |
| L | Cleveland-Cliffs Iron Co. |
| M | A Mesabi Range beneficiation plant |
| N | Jones and Laughlin Steel Co. |
| O | Reserve Mining Co. |
| P | A potash plant |
| Q | Harmar Coal Co. |
| R | Harmar Coal Co. |
| S | De Bardeleben Co. |
| T | American Cyanamid Co. |
| U | Owens Illinois Glass Co. |
| V | Calaveras Cement Co. |
| W | Dravo Corp. |
| X | Carborundum Co. |

## Index II

| Item | Description |
|---|---|
| 1 | Type of material treated |
| 2 | Cyclones used for either desliming or closed circuit grinding |
| 3 | Name of cyclone manufacturer { E. E. = Equipment Engineers Inc.; D-O = Dorr-Oliver Inc.; H & P = Heyl and Patterson |
| 4 | Diameter of cyclone |
| 5 | Area and type of feed opening (a = rectangular, b = round) |
| 6 | Diameter of spigot discharge |
| 7 | Diameter of overflow opening |
| 8 | Angle of cone (including angle at the apex) |
| 9 | Volume flow of pulp through cyclone, gpm |
| 10 | Inlet pressure, psi |
| 11 | Solids in feed pulp, wt pct |
| 12 | Solids in overflow pulp, wt pct |
| 13 | Solids in spigot pulp, wt pct |
| 14 | Cyclone feed pump size |
| 15 | Pump horsepower required |
| 16 | Static head |
| 17 | Type of pump liner |
| 18 | Life of pump liner |
| 19 | Type of cyclone liner |
| 20 | Life of cyclone liner |



Bank of six cyclones operating on Deister clean coal circuit.



**Table II. Screen Analysis of Products**

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|

## Table I. Operating Data

| Item | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | Copper ore | Copper ore | Fe sulfide concentrate | Copper tailing | Cu-Pb-Zn ore | Ilmenite ore | Molybdenum flotation tails | Gold ore |
| 2 | c.c.g. | Desliming | c.c.g. | Desliming | c.c.g. | Desliming | Desliming | c.c.g. |
| 3 | E.E. | Staver Foundry | D-O | E.E. | E.E. | Own design | D-O and homemade | E.E. |
| 4 | 20 in. | 24 in. | 24 in. | 10 in. | 20 in. | 12 in. | 24 in. | 20 in. |
| 5 | a<br>21 sq in. | b<br>15.9 sq in. | a<br>18 sq in. | a<br>4.8 sq in. | b<br>4-in. diam | a<br>5 sq in. | a<br>32 sq in. | a<br>20 sq in. |
| 6 | 1⅝ to 1⅞ in. | 3⅛ in. | 3.8 to 5.4 in. 5.4 in. normal | 1⅜ in. | 1¾ to 1⅞ in. | 1¼ in. | 2.5 in. | 2⅜ to 2⅝ in. |
| 7 | 7½ in. | 4⅝ in. | 6 in. | 3 in. | 6 in. | 2½ in. | 8 in. | 7½ in and 6¾ in. |
| 8 | 20° | 20° | 20° | 20° | 20° | 10° | 20° | 20° |
| 9 | 600 | 550 to 700 | 744 | 220 | 325 | 435 | 1100 | 490 |
| 10 | 7 to 8 | 23 to 32 | 14 | 25 | 7 | 50 | 25 | 5 |
| 11 | 48 | 19 to 23 | 56.5 | 32 | 52 | 5 to 8 | 38 | 37 |
| 12 | 31 | 9 to 12 | 42.7 | 20 | 29 | 1 to 2 | 33 | 16 |
| 13 | 74 | 33 to 38 | 74.5 | 75 | 80 | 72 | 63 | 68 |
| 14 | 8 in. (2 cyclones) | Hydroseal D-41-5 | 8 x 6 CAC-C | Wemco 4 in. | Wilfley 4 in. | 2 to 5 in. (6 cyclones) | Hydroseal D-3-5 | Hydroseal C-10-5 (2 cyclones) |
| 15 | 40(2 cyclones) | 200 | 18.9 | — | — | 150 (6 cyclones) | 145 | — |
| 16 | 17 | — | 18 | 12 | 18 | 4 to 7 | 24 | 20 |
| 17 | — | Neoprene rubber | Rubber | — | — | Cast iron | Rubber | — |
| 18 | — | 4000 to 6000 hr | Footnote a | — | — | Case-6 months Impeller-2 months | — | — |
| 19 | Gum rubber | Cast Ni-Hard | Cyclone head Ni-Hard | Gum rubber | Gum rubber | Ni-Hard (no liner) | Rubber | Rubber |
| 20 | No replacement after 1 million tons | 1200 to 1500 hr | 1,263,800 dry tons | None in 2 years | — | 6 to 8 months | — | — |

| Item | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|
| 1 | Gold ore | Tungsten ore | Iron ore | Iron ore | Iron tailings | Iron ore | Iron ore | Sylvinite ore |
| 2 | Desliming | Desliming | Desliming | Desliming | Desliming (two-stage) | Desliming | Desliming | c.c.g. |
| 3 | E.E. | E.E. | D-O | D-O | E.E. | Homemade | H and P | D-O |
| 4 | 20 in. | 10 in. | 24 in. | 6 in. | Cylinder 20 in. Cone 9 in. | 14 in. | 14 in. | 24 in. |
| 5 | a<br>13 sq in. | a<br>4 sq in. | a<br>22 sq in. | a<br>1.25 sq in. | a<br>12 sq in. | b<br>12.6 sq in. | b<br>2½-in. diam | a<br>32 sq in. |
| 6 | 1⅝ in. | 1¼ in. | 4 in. | ½ in. | 1⅝ in. | 1 in. | 2 in. | 6 in. |
| 7 | — | 2½ in. | 8 in. (footnote b) | 3 in. (footnote c) | Primary 5¼ in. Secondary 2 in. | 5½ in. | 5½ in. | 5 in. |
| 8 | 20° | 20° | 20° | 20° | 20° (secondary) | 15° | 14° | 20° |
| 9 | 400 | 200 | 1170 to 1200 | 1100 to 1200 (24 cyclones) | 500 to 600 | 600 | 395 | 800 |
| 10 | 10 | 26 | 13 to 15 | 45 to 47 | 15 | 50 | 15 | 13 |
| 11 | 13 | 25 | 30 | 12 to 15 | 23.6 | 7 | 36.8 | 64 |
| 12 | 7.5 | 5 | 12 to 15 | 1 to 2 | Primary 13.0 Secondary 25.7 | 1.5 | 14.7 | 38 |
| 13 | 62.0 | 74 | 67 to 73 | 20 | 72.8 | 66 to 70 | 78.3 | — |
| 14 | Hydroseal C-10-5 (2 cyclones) | Wemco 4 in. | Allen-S-H 8 in. | 2 A-S-4(8 in.) (24 cyclones) | 10-in. Hydroseal (5 cyclones) | 6 in. | — | 8-in. Wilfley |
| 15 | — | 15 | 80 | 80 each | — | 50 | — | 75 |
| 16 | 10 | 15 | 35 | 35 | — | 18 | — | — |
| 17 | — | — | Natural rubber | Natural rubber | Rubber | Rubber | — | Cast iron |
| 18 | — | — | No apparent wear yet | No apparent wear yet | Still good after 2 years | — | — | 260,000 tons |
| 19 | Rubber | Rubber | Natural rubber | Natural rubber | Gum rubber | Linatex | — | Rubber |
| 20 | — | No replacement in 2 years | No apparent wear yet | No apparent wear yet | Still good after 2 years | — | — | Not determined |

| Item | Q | R | S | T | U | V | W | X |
|---|---|---|---|---|---|---|---|---|
| 1 | Coal | Coal | Coal | Phosphate slurry | Glass sand | Cement rock | Sand | Carborundum |
| 2 | Desliming | Desliming | Desliming | Desliming | Desliming | c.c.g. | Desliming | Desliming |
| 3 | H and P | H and P | H and P | Homemade | E.E. | E.E. | H and P | H and P |
| 4 | 14 in. | 3 in. | 14 in. | 48 in. | 10 in. | 20 in. | 14 in. | 8 in. |
| 5 | b<br>2½-in. diam | a<br>⅝ x 5/16 in. | b<br>2½-in. diam | a<br>40 sq in. | a<br>4.8 sq in. | a<br>12 sq in. | b<br>2½-in. diam | b<br>1¼ in. |
| 6 | 1¼ in. | ¼ in. | 1¼ in. | 3½ and 4 in. | 1¼ to 1⅝ in. | 2⅞ to 3⅛ in. | ⅞ in. | ½ in. |
| 7 | 2½ in. | ½ in. | 2½ in. | 9 in. | 3 in. | 6 in. | 6 in. | 1½ in. |
| 8 | 14° | 14° | 14° | 10° | 20° | 20° | 14° | 14° |
| 9 | 250 | 220(22 cyclones) | 225 | 2,000 | 240 | 700 | 490 | 86.8 |
| 10 | 35 | 40 | 25 | 25 | 23 | 18 to 22 | 40 | 20 |
| 11 | 10.6 | 7.9 | 8.1 | 26 to 28 | 25 to 27 | 50 to 55 | 2.5 | 1.2 |
| 12 | 7.9 | 5.4 | 4.4 | 5 to 8 | 13 to 14 | 34 to 36 | 0.4 | 0.5 |
| 13 | 53.8 | 25.1 | 57.4 | 60 to 66 | 70 to 72 | 76 to 77 | 72.6 | 13.5 |
| 14 | 6 in. | 6 in. | — | G.I.W. 37-in. impeller | 6-in. Hydroseal | Hydroseal C-6-5 | A.S.H. 6-in. impeller | A.S.H. 12-in. impeller |
| 15 | 50 | 40.5(22 cyclones) | — | 650 to 700 B.H.P. 5 to 7 cyclones | 40 | 40 | 50 (two cyclones) | 7½ |
| 16 | 119 | 104 | — | 75 | 18 | 20 | — | — |
| 17 | Ni-Hard | Ni-Hard | — | Ni-Hard | Rubber | — | Rubber | Rubber |
| 18 | — | — | — | Impeller 500,000 tons | Very moderate | — | — | — |
| 19 | Gum rubber | Gum rubber | — | Rubber | Gum rubber | Gum rubber | — | — |
| 20 | — | — | — | Footnote d | No replacement in 2½ years | Negligible in 10 months | — | — |

## Table II. Screen Analysis of Products

| Product | A Mesh | A Wt, Pct | B Mesh | B Wt, Pct | C Mesh | C Wt, Pct | D Mesh | D Wt, Pct | E Mesh | E Wt, Pct | F Mesh | F Wt, Pct | G Mesh | G Wt, Pct | H Mesh | H Wt, Pct |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feed | +65 | 22.0 | +65 | 0.3 | | | +65 | 4.0 | +48 | 25.6 | +100 | 3.4 | +48 | 7.8 | +8 | 3.0 |
| | +100 | 14.4 | +100 | 3.4 | +100 | 5.7 | +100 | 8.5 | +65 | 16.9 | +150 | 5.8 | +65 | 9.6 | +10 | 1.8 |
| | +150 | 10.2 | +150 | 8.2 | +150 | 23.8 | +150 | 7.5 | +100 | 12.0 | +200 | 13.5 | +100 | 11.8 | +28 | 10.5 |
| | +200 | 7.2 | +200 | 6.1 | +200 | 20.6 | +200 | 10.0 | +150 | 10.1 | +325 | 19.3 | +150 | 12.2 | +48 | 14.0 |
| | −200 | 46.2 | +325 | 11.7 | −200 | 49.9 | +325 | 7.9 | +200 | 8.3 | +20M | 15.1 | +200 | 8.8 | +80 | 16.2 |
| | | | −325 | 70.3 | | | −325 | 62.1 | −200 | 27.1 | +10M | 15.7 | −200 | 49.8 | +100 | 11.1 |
| | | | | | | | | | | | +5M | 12.7 | | | +150 | 11.7 |
| | | | | | | | | | | | +3M | 6.4 | | | +200 | 9.5 |
| | | | | | | | | | | | −3M | 8.1 | | | −200 | 22.5 |
| Spigot | +65 | 60.9 | +65 | 0.4 | +100 | 9.9 | +65 | 9.2 | +48 | 38.1 | +100 | 2.9 | +48 | 21.3 | +8 | 4.0 |
| | +100 | 16.5 | +100 | 5.6 | +150 | 35.7 | +100 | 18.4 | +65 | 22.5 | +150 | 8.9 | +65 | 20.4 | +10 | 2.0 |
| | +150 | 9.3 | +150 | 12.5 | +200 | 27.7 | +150 | 16.4 | +100 | 12.0 | +200 | 19.2 | +100 | 17.4 | +28 | 14.0 |
| | +200 | 3.2 | +200 | 9.2 | −200 | 26.7 | +200 | 19.2 | +150 | 10.1 | +325 | 26.6 | +150 | 11.7 | +48 | 18.5 |
| | −200 | 10.1 | +325 | 16.2 | | | +325 | 16.4 | +200 | 7.2 | +20M | 19.1 | +200 | 7.2 | +80 | 21.5 |
| | | | −325 | 56.1 | | | −325 | 20.4 | −200 | 10.1 | +10M | 14.0 | −200 | 22.0 | +100 | 13.3 |
| | | | | | | | | | | | +5M | 5.1 | | | +150 | 11.9 |
| | | | | | | | | | | | +3M | 2.6 | | | +200 | 7.4 |
| | | | | | | | | | | | −3M | 1.6 | | | −200 | 7.4 |
| Overflow | +65 | 5.1 | | | | | | | +48 | 1.2 | +325 | 2.0 | +48 | 2.2 | +80 | 0.8 |
| | +100 | 11.0 | | | +100 | 0.8 | | | +65 | 5.7 | +20M | 9.8 | +65 | 4.3 | +100 | 4.6 |
| | +150 | 10.6 | | | +150 | 5.4 | | | +100 | 12.1 | +10M | 22.6 | +100 | 9.8 | +150 | 11.1 |
| | +200 | 9.4 | +325 | 1.0 | +200 | 11.9 | +200 | 0.4 | +150 | 10.5 | +5M | 26.4 | +150 | 12.0 | +200 | 15.6 |
| | −200 | 63.9 | −325 | 99.0 | +200 | 81.9 | +325 | 1.4 | +200 | 10.1 | +3M | 17.6 | +200 | 10.7 | −200 | 67.9 |
| | | | | | | | −325 | 98.2 | −200 | 60.4 | −3M | 21.6 | −200 | 61.0 | | |

| Product | I Mesh | I Wt, Pct | J Mesh | J Wt, Pct | K Mesh | K Wt, Pct | L Mesh | L Wt, Pct | | M Mesh | M Wt, Pct | N Mesh | N Wt, Pct | O Mesh | O Wt, Pct | P Mesh | P Wt, Pct |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feed | +80 | 0.8 | +35 | 9 | +48 | 1.6 | | | | +48 | 1.2 | +48 | 2.4 | +16 | 1 | +28 | 30.8 |
| | +100 | 4.6 | +48 | 9 | −325 | 32.3 | | | | +100 | 6.7 | +65 | 4.8 | +32 | 3 | +100 | 71.0 |
| | +150 | 11.1 | +65 | 11 | | | | | | +200 | 11.1 | +100 | 11.2 | +60 | 9 | | |
| | +200 | 15.6 | +100 | 15 | | | | | | +325 | 20.9 | +150 | 14.0 | +100 | 12 | | |
| | −200 | 67.9 | +150 | 13 | | | | | | −325 | 60.0 | +200 | 12.8 | +200 | 28 | | |
| | | | +200 | 6 | | | | | | | | +325 | 20.8 | +325 | 19 | | |
| | | | +325 | 13 | | | | | | | | −325 | 34.0 | −325 | 28 | | |
| | | | −325 | 24 | | | | | | | | | | | | | |
| Spigot | +80 | 1.3 | +35 | 10.0 | +48 | 1.3 | +150 | 7.1 | | +48 | 12.5 | +48 | 3.6 | +16 | 2 | +28 | 51.6 |
| | +100 | 7.1 | +48 | 10.4 | −325 | 25.4 | −325 | 86.8 | | +100 | 34.5 | +65 | 7.6 | +32 | 6 | +100 | 85.9 |
| | +150 | 17.0 | +65 | 13.3 | | | +20M | 88.7 | | +200 | 18.3 | +100 | 15.6 | +60 | 16 | | |
| | +200 | 22.8 | +100 | 18.1 | | | | | | +325 | 17.5 | +150 | 20.2 | +100 | 19 | | |
| | −200 | 51.8 | +150 | 15.6 | | | | | | −325 | 17.2 | +200 | 18.6 | +200 | 31 | | |
| | | | +200 | 6.7 | | | | | | | | +325 | 22.4 | +325 | 17 | | |
| | | | +325 | 15.1 | | | | | | | | −325 | 12.0 | −325 | 9 | | |
| | | | −325 | 10.8 | | | | | | | | | | | | | |
| Overflow | +200 | 0.4 | −325 | 100.0 | +150 | 3.0 | +150 | 0.9 | Primary | +325 | 13.0 | +65 | 2.0 | +200 | 6 | +28 | 7.5 |
| | −200 | 99.6 | | | −325 | 66.9 | −325 | 88.0 | | −325 | 87.0 | +100 | 2.0 | +325 | 12 | +100 | 38.4 |
| | | | | | | | −20M | 62.8 | | | | +150 | 3.0 | −325 | 81 | | |
| | | | | | | | | | | | | +200 | 4.0 | | | | |
| | | | | | | | | | Secondary | +100 | 0.4 | +325 | 16.0 | | | | |
| | | | | | | | | | | +200 | 4.3 | −325 | 73.0 | | | | |
| | | | | | | | | | | +325 | 21.1 | | | | | | |
| | | | | | | | | | | −325 | 74.2 | | | | | | |

| Product | Q Mesh | Q Wt, Pct | R Mesh | R Wt, Pct | S Mesh | S Wt, Pct | T Mesh | T Wt, Pct | U Mesh | U Wt, Pct | V Mesh | V Wt, Pct | W Mesh | W Wt, Pct | X Mesh | X Wt, Pct |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feed | +16 | 0.1 | +100 | 0.4 | +32 | 3 | −8 +150 | 72.0 | +35 | 0.4 | | | +32 | 1 | +100 | 3 |
| | +32 | 0.5 | +200 | 6.5 | +60 | 12 | −150 | 28.0 | +48 | 2.3 | | | +60 | 7 | +60 | 7 |
| | +60 | 4.4 | +325 | 7.6 | +115 | 11 | | | +65 | 17.1 | | | +100 | 15 | +40 | 23 |
| | +100 | 7.4 | −325 | 85.5 | +250 | 10 | | | +100 | 28.9 | | | +200 | 32 | +20 | 31 |
| | +200 | 14.3 | | | +325 | 8 | | | +200 | 10.0 | | | +325 | 22 | +10 | 13 |
| | +325 | 8.0 | | | −325 | 56 | | | −200 | 41.3 | | | −325 | 23 | −10 | 33 |
| | −325 | 65.3 | | | | | | | | | | | | | | |
| Spigot | +16 | 1.4 | +100 | 1.2 | +32 | 18 | +150 | 95.0 | +35 | 0.7 | | | +32 | 2 | +100 | 7 |
| | +32 | 2.4 | +200 | 20.3 | +60 | 47 | −150 | 5.0 | +48 | 3.9 | | | +60 | 9 | +60 | 13 |
| | +60 | 18.4 | +325 | 20.2 | +115 | 20 | | | +65 | 20.2 | | | +100 | 24 | +40 | 36 |
| | +100 | 31.0 | −325 | 58.3 | +250 | 5.5 | | | +100 | 49.2 | | | +200 | 34 | +20 | 30 |
| | +200 | 26.3 | | | +325 | 2.7 | | | +200 | 15.5 | | | +325 | 20 | +10 | 3 |
| | +325 | 6.8 | | | −325 | 6.8 | | | −200 | 1.5 | | | −325 | 11 | −10 | 2 |
| | −325 | 13.7 | | | | | | | | | | | | | | |
| Overflow | +100 | 0.4 | +100 | 0.1 | +60 | 5 | +150 | 1 to 2 | +200 | 2.3 | +100 | 0.2 | +200 | 1 | +60 | 1 |
| | +200 | 6.5 | +200 | 0.6 | +115 | 13 | −150 | 98 to 99 | −200 | 97.7 | +150 | 4.0 | +325 | 2 | +40 | 3 |
| | +325 | 7.6 | +325 | 1.3 | +250 | 11 | | | | | +200 | 8.2 | −325 | 97 | +20 | 26 |
| | −325 | 85.5 | −325 | 98.0 | +325 | 6 | | | | | −200 | 87.6 | | | +10 | 25 |
| | | | | | −325 | 65 | | | | | | | | | −10 | 45 |

Gland side = 3,424,600 tons.
Suction side = 1,608,100 tons.
Casting side = 2,292,100 tons.
Vortex finder = 6-in. diam.
Vortex finder = 1-in. diam.
350,000 tons spigot for upper parts.
30,000 tons spigot for apex.

SYMPOSIUM

CYCLONES

# Use of Cyclones in the Grinding of Taconite

by Fred D. DeVaney

MINNESOTA taconites are extremely hard, and fine grinding is required to produce an acceptable concentrate. To reduce grinding costs, waste material is rejected by magnetic separators as soon as it is liberated. Cyclones are now used in all Minnesota taconite plants to close the grinding circuits.

Erie Mining Co. installed its first grinding section at Aurora, Minn., in 1948—a 9½x12-ft. mill and a fine grinding section consisting of a 10½x12-ft ball mill in closed circuit with a duplex 60-in. spiral classifier. Concentrates from the magnetic cobbers treating the rod mill discharge passed directly into the classifier; the ball mill discharge was also treated in magnetic separators and the concentrate from these machines also went to the spiral classifier. Both concentrates passed through ac demagnetizing coils. It is axiomatic that for proper classification the material in suspension must be well dispersed, and it follows that magnetic concentrate must be almost completely depolarized if classification is to be successful.

Complete demagnetization proved difficult to attain. The coercive force of magnetite particles is a function of their surface and is a measure of the power required to demagnetize them. It therefore proved relatively easy to demagnetize granular material of 20 $\mu$ or over, but virtually impossible in a continuous mill operation to demagnetize completely particles finer than 5 $\mu$. The presence of these finely magnetized slime particles interfered seriously with this type of classification and the operator was unable to control the size of overflow to the desired degree.

A laboratory study of cyclones for size classification offered possibilities for improvement. The installation was changed over to cyclone sizing in 1951 and the mill has been operated with cyclones ever since. Cyclones are also being installed in Erie's 7½-million ton 27-section mill now approaching completion. For the following reasons they have been found especially desirable in size classification of taconite: 1) there is no demagnetizing problem; 2) separation size is easily controlled; 3) water consumption is lower; 4) initial cost is lower; 5) less space is needed; 6) no ball mill scoop is required; and 7) circulating load is adjustable.

These reasons should be elaborated. At Pickands Mather & Co. feed to the cyclone is customarily demagnetized, but this is no longer an important factor, since the forces present in a cyclone are so great that complete depolarization is not necessary. Size of particles in the overflow can now be easily regulated. This adjustment in grain size can be accomplished in a number of ways. The

Aerial view of Erie taconite plant looking south.

F. D. DEVANEY is Chief Metallurgist of Pickands Mather & Co., Duluth.

method most commonly used for day to day mill operation is to dilute the cyclone feed. For the same size of overflow product, it has been found that a product of higher density can be obtained in a cyclone than in a spiral classifier overflow. This is important for several reasons. Less water is required, and capacity of the magnetic separators is increased because the capacity of any magnetic separator is a function not only of the tons of dry feed coming to the machine, but also of the gallonage of this product. Initial cost of a cyclone installation—including the cyclones themselves, the pump for furnishing the head to the cyclones, and the auxiliary equipment—is considerably less than for a gravity type of classifier.

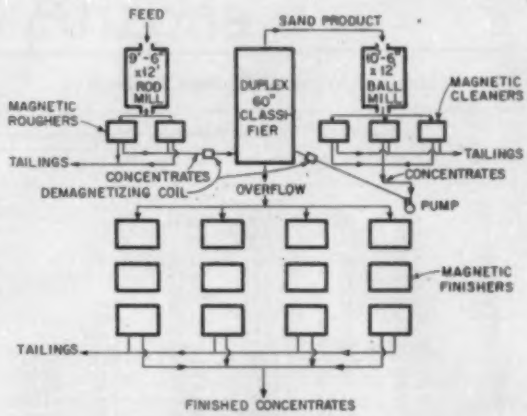
Width of the mill section is usually determined by the space needed for the grinding mill and the type of classifier required to close this circuit. With a gravity type of classifier, considerable extra room is required. No extra width need be provided for the cyclone installation, as cyclones are mounted over the feed opening to the ball mill. The product is discharged directly into the ball mill chute, and no ball mill scoop is necessary. In the Erie mill the width of a single mill section with cyclones can be held to 30 ft; if conventional classifiers were used this width would be 42 ft. In a large mill with individual sections, this means substantial savings in mill building cost and in heating.

Since a relatively small amount of material circulates in the cyclones, the mill circuit can be shut down almost instantly, and changes in circulating load or in sizing characteristics can be quickly made. Because the scoop can be eliminated from the ball mill, capital cost of the unit is somewhat lowered and one more maintenance item is cancelled.

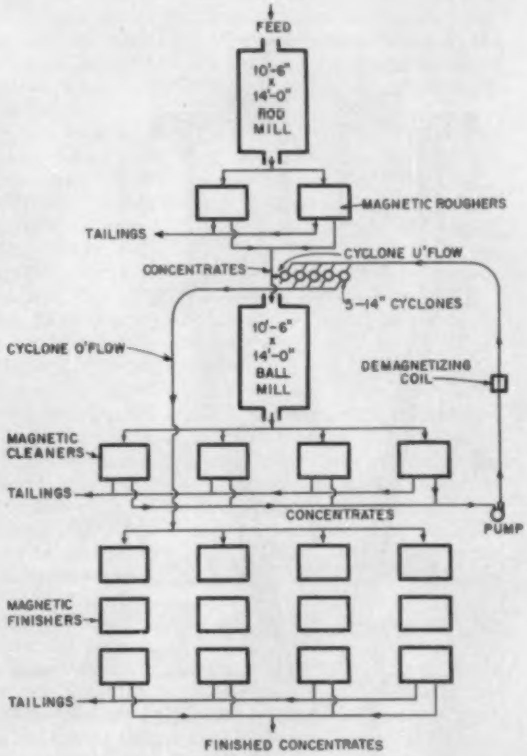
As used in the taconite industry, cyclones require more power than the conventional classifier—0.5 to 1.00 kw-hr per ton of feed, depending on the pumping load.

Cyclones of small diameter are customarily used in this industry. Cyclones of 10, 12, and 14-in. diam have been used in the past, but it is believed that 12 and 14-in. diam will be the standard size in the future. These diameters have been chosen rather than larger ones because they permit increased sharpness of separation. On these ores, it is extremely important that the cyclone overflow contain a minimum of oversize tramp, as this material is of very low grade and will seriously contaminate the quality of the finished concentrates. Because of variations in grindability of the ore it is desirable to vary the circulating load by adding or shutting off cyclones in the circuit. Under these circumstances a higher percentage of solids can be attained with smaller diameter cones.

The cyclone design at Erie Mining Co. has been changed from time to time, and the present design is the result of a number of years of test work. After the dimensions of the cyclone were worked out, particular attention was given to wear parts. All wear-resistant materials that showed any promise were tested, and as now fabricated, these cyclones require little maintenance. In the design shown the shell itself is made of mild steel. The interlining of the cyclone is made up of four molded rubber wear surfaces. It has been found that the best lining is one of soft rubber having a durometer number of 25 to 45. Nihard linings have been used for these parts, but rubber lasts much longer. Linatex wears about as well as molded lining, but maintenance is higher, as cementing in place takes time—unless it is done carefully the material peels off. Present linings are about 1 in. thick. This considerable thickness has been chosen because it offers greater resilience and also longer life. The inlet nozzles, made of Nihard, have a round cross section and in a year will wear from 2¼ to 2½ in., at which time they are replaced. The cyclone apexes are made of a silicon carbide pro-




**Original Erie grinding circuit used classifiers.**



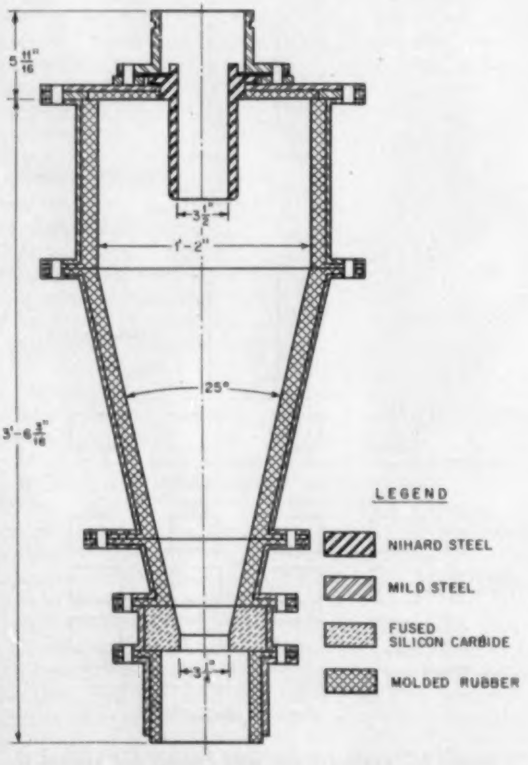

**Present Erie grinding circuit using cyclones and adopted in 1951, can be compared with flowsheet above.**

### Erie Cyclone Data

| | |
|---|---|
| Diameter: 14 in. | Feed nozzle discharge diameter: 2½ in. |
| Apex: 3¼ in. | Vortex finder diameter: 3½ in. |
| Cone angle: 25° | Pressure: 20 to 25 lb |
| **Solids, Pct** | |
| Feed: 50 to 63 pct | Overflow: 15 to 32 pct; Underflow: 75 to 82 pct |
| **Capacity** | |
| 280 gpm per cyclone | 45 to 75 dry long tons of feed per cyclone |
| **Materials** | |
| Shell | 3/16-in. mild steel |
| Feed inlet lining | 1-in. molded rubber; 25 to 45 Durometer |
| Upper cone lining | 1-in. molded rubber; 25 to 45 Durometer |
| Lower cone | 1-in. molded rubber; 25 to 45 Durometer |
| Spray guard | ¾-in. molded rubber; 25 to 45 Durometer |
| Feed inlet cover lining | ½-in. Linatex |
| Apex nozzle | 3-in. thick fused silicon carbide |

### Screen Analysis of Cyclone Products

| Mesh | Cyclone Feed | | Cyclone Underflow | | Cyclone Overflow | |
|---|---|---|---|---|---|---|
| | Wt, Pct | Iron, Pct | Wt, Pct | Iron, Pct | Wt, Pct | Iron, Pct |
| 4 | 0.17 | | 0.20 | | | |
| 6 | 0.22 | 32.14 | 0.25 | 32.14 | | |
| 8 | 0.43 | | 0.49 | | | |
| 10 | 0.91 | | 1.04 | | | |
| 14 | 1.84 | 31.06 | 2.11 | 31.06 | | |
| 20 | 2.93 | 36.05 | 3.36 | 36.05 | | |
| 28 | 3.54 | 39.60 | 4.06 | 39.60 | | |
| 35 | 3.63 | 40.17 | 4.13 | 40.29 | 0.21 | |
| 48 | 4.42 | 40.61 | 5.03 | 41.07 | 0.21 | 26.94 |
| 65 | 8.68 | 40.73 | 9.89 | 41.85 | 0.42 | |
| 100 | 12.17 | 42.59 | 13.78 | 43.09 | 1.18 | 27.67 |
| 150 | 15.15 | 47.95 | 16.75 | 49.57 | 4.23 | 28.49 |
| 200 | 14.26 | 54.26 | 15.41 | 55.73 | 6.41 | 30.07 |
| 325 | 14.30 | 57.17 | 14.34 | 58.90 | 14.00 | 45.02 |
| −325 | 17.35 | 55.91 | 9.16 | 57.45 | 73.34 | 54.59 |
| Total | 100.00 | 48.43 | 100.00 | 48.52 | 100.00 | 50.02 |
| Heads | | 47.85 | | 47.86 | | 49.78 |
| Wt, pct | | 421.47 | | 367.66 | | 53.81 |
| Solids, pct | | 62.00 | | 80.00 | | 26.30 |




Erie design 14-in. cyclone.

duct, and these have proved very satisfactory, lasting as long as nine months without any apparent loss in gage. Life of the rubber liner parts, and presumably other cyclone parts, is affected greatly by the pressure at which these cyclones operate. At the Reserve Co. plant, for example, where cyclone pressures are usually held in the 18 to 20-lb range, the life of a molded rubber lining will probably not be less than three years. At Erie, where the operating pressure is held at about 25 lb, average life of liners is one year. At another Range plant, where pressures up to 35 lb have been used, liner life may be only a few months.

At the start of the operation, wear of header pipes supplying the cyclone proved serious, but installation of 60° Nihard laterals greatly reduced this maintenance problem. The individual cyclone, of course, must be operated in a completely open or completely off position, and for this duty a 4-in. Grigsby-type valve is used. It has also been found expedient to reduce maintenance on curves from the pump to the cyclone by making the curves of ⅜-in. gum rubber sleeves with a large radius of curvature.

Four bolts hold a cyclone in place over the feed inlet to the ball mill. When in need of repair, the entire cyclone is lifted out of place by a hoist and replaced by one that has been repaired.

Data on cyclones at Erie given in one of the accompanying tables show considerable variation in the percent solids in the overflow. This dilution is the chief control used to vary the size of grind. If the ore liberates at a fairly coarse grind, say with 65 pct of the overflow finer than 325 mesh, the overflow solids can be maintained at about 30 pct. If the ore is fine and requires grinding to 90 pct -325 mesh, this figure must be reduced to approximately 15 pct. There has been no difficulty in maintaining a percentage of solids in the cyclone underflow that is satisfactory for ball mill grinding.

The sizing analyses of typical Erie cyclone products show that a high circulating load is maintained in the grinding circuit. For the purpose of comparison, it may be assumed that the feed to the rod mill circuit is 100 pct. No particular attempt is made to secure a good rejection of the −325 mesh material in the cyclone underflow, as all sizes coarser than 200 mesh yield a marginal concentrate. It is also desirable, for pelletizing, to maintain at least 65 pct -325 mesh in the concentrate.

In the Erie cyclone circuit the sump level is held constant by an ac motor-driven pump and an American Blower reducing unit. The percentage of solids is continuously recorded by a strain gage, which weighs a spiral hose measuring device that is always full. At present the amount of water in the cyclone feed is adjusted manually, but plans are under way to make this adjustment automatic from impulses received from the spiral hose strain gage apparatus. At the Reserve Co. plant a Ramsey coil measures the percentage of magnetic material in the pulp and a Foxboro flowmeter measures the quantity. The two, when integrated together, give a figure representing the tons of magnetic material passing through the pipe. By this means feed is adjusted to the rod mill circuit automatically so that a constant circulating load is maintained to the ball mill and through the cyclones.

# Cyclone Practice in Arizona

by Russell Salter and Edwin J. King

SINCE 1950, when perhaps two or three cyclones were being tested in Arizona, the number in use has grown to about 100. Most of these have come into operation within the last two or three years, and according to information supplied by various mining companies, the number will continue to grow for several years more.

In mills that have been recently constructed, cyclones dominate the fine classification field, removing grit from lime slurries, producing smelter flux, reducing concentrate thickener overloads, classifying molybdenite in grinding circuits, and conditioning flotation feed. Four major copper companies are now testing cyclones in primary grinding circuits, and one concentrator soon to begin operation will classify entirely with cyclones. In at least two instances these versatile machines have been given a vital role in the construction of tailings disposal systems.

In short, there remain very few classifying operations in which cyclones are not being used, tested, or actively considered. But such rapid growth has not been entirely without problems.

### Cyclones at Morenci

**Primary Grinding Circuit:** The testing of cyclones as primary grinding circuit classifiers at Morenci was started in February 1954, with one 20-in. cyclone classifying part of the discharge from one 10x10-ft ball mill. Several months later a 30-in. cyclone was placed in service, handling all of one ball mill discharge. This circuit was operated for about 16 months, during which time satisfactory classification was obtained at a higher overflow density than could be achieved with the spiral classifiers in use in other grinding circuits. The extremely short pump life in this first test circuit has dictated much of the Morenci cyclone development.

Designed to eliminate most of the coarse particles from the cyclone feed pump, which were considered to be the cause of the severe abrasion, two circuit modifications were tested. One, a launder classifier, consisted of a sheet of boiler plate set horizontally in the mill discharge launder and raised 1¼ in. from the bottom of the launder. Material that underflowed the plate bypassed the pump and returned directly to the mill scoop box. Material overflowing the plate was pumped to the cyclone. This launder classifier removed about 65 pct of the +3/16-in. particles from the mill discharge product, together with a fairly high percent of −200 mesh material.

In the second circuit modification, one of the two duplex Akins classifiers was used to remove the tramp ahead of the cyclone feed pump. This circuit is currently being tested at Morenci and has been the forerunner of similar test circuits at Copper Cities, Silver Bell, and Cananea. Maintenance and operating notes and the data presented in accompaying tables all pertain to this circuit.

An 8-in. pump, driven at 650 rpm, has been in use for about one year to supply feed to the 30-in. cyclone in the Morenci test circuit. Various metal and rubber impellers and casings have been tried during this period. Metal impeller life was reported to be 35 to 53 days, rubber impeller life 136 days, and rubber casing life 208 days. On the cyclones the greatest amount of wear appeared in the lower 14 in. of the cone. The pneumatic tire that served as an apex valve had a tendency to lose pressure after being in service for several days. There was some wear in the cyclone overflow piping, but very little in the feed piping.

Dilution water to the Akins classifier, tonnage input to the circuit, and apex valve size adjustment are listed as the operating controls of classification size. An adjustable gate on the suction side of the cyclone feed pump is used to prevent pump surges. The operators report that during changes in character of ore this dual classification circuit becomes unbalanced more easily than the normal ball mill-spiral classifier circuits.

R. SALTER is Mill Superintendent and E. J. KING Assistant Mill Superintendent, Silver Bell Unit, American Smelting & Refining Co., Silver Bell, Ariz.

## Cyclone Design and Flow Data

| | 3 In. | 10 In. | | | | 12 In. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Plant** | Silver Bell | Silver Bell | Copper Cities* | Copper Cities** | Magma | Silver Bell | Magma | Magma | Cananea | Southwestern Concentrator |
| **Circuit Position** | Molybdenum Regrind | Tailing Dam | Regrind | Lime | Regrind | Regrind | Spiral Flux-Meter | Thick* | Regrind** | Regrind** |
| Number in operation | 1 | 6 | 4 | 2 | 4 | 2 | 1 | 1 | 2 | 4 |
| Cone angle, degrees | 20 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 20 | 20 |
| Cylinder length, in. | 0 | 10 | 10 | 10 | 8 | — | 10 | 10 | 10 | — |
| Feed inlet, sq in. | 0.313 | 4.8 | 7.07 | 7.07 | 3.14 | 5.0 | 4.91 | 4.91 | 12 | 12 |
| Vortex finder diam, in. | 0.75 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 6.0 | 6.0 | 5.0 | 5.0 |
| Apex opening, diam in. | 0.87 | 1.5 | 1.0 | 1.25 | 1.25 | 2 to 3 in. | 0.625 | 0.50 | 2.0 | 3 to 4 |
| Cyclone make | Dorr | Krebs | Krebs | Krebs | Magma | Dorr | Magma | Magma | Dorr | Dorr |
| Feed inlet pressure, psi | 5 to 15 | 2 to 5 | 6 | 3 | 10 | 25 | 10 | 8 | 4 to 5 | 16 |
| Feed volume, gpm | 12 | 100 | 400 | ? | 400 | 400 | 410 | 185 | 835 | 2802 |
| Feed solids, pct | 18 | 47 | 40 | 35 | 41.2 | 40 | 20.0 | 27.6 | 27 | 24.3 |
| Feed tph, dry, new feed | 0.21 | 16.4 | 15 | — | 27.9 | 18.8 | 23.4 | 16.0 | 70 | 208 |
| Feed tph, dry, cyclone | 0.63 | 16.4 | 60 | — | 59.1 | 75.2 | 23.4 | 16.0 | 70 | 208 |
| Feed −200 mesh, pct | 100 | 54 | 60.9 | 43.1 | 72.0 | 69 | 70.6 | 86.2 | 68.0 | 77.3 |
| Overflow, volume, gpm | 0.10 | 80 | 340 | ? | 320 | 176 | 400 | 175 | 725 | 2430 |
| Overflow, solids, pct | 8 | 41 | 15 | 25 | 26.4 | 20 | 18.0 | 23.0 | 14 | 11.7 |
| Overflow, tph, dry solids | 0.21 | 11.1 | 15 | — | 28.7 | 18.8 | 20.2 | 12.2 | 28 | 77.4 |
| Overflow, −200 mesh, pct | 100 | 68 | 91.2 | 80.7 | 95.3 | 93 | 72.4 | 94.1 | 91.6 | 95.5 |
| Underflow, volume, gpm | 2 | 20 | 60 | ? | 80 | 224 | 10 | 10 | 110 | 372 |
| Underflow, solids, pct | 50 | 67 | 75 | 40 | 72 | 70 | 70.8 | 71.3 | 73.5 | 67.1 |
| Underflow, tph, dry solids | 0.42 | 5.3 | 45 | — | 30.4 | 56.4 | 3.1 | 3.9 | 42 | 131 |
| Underflow, −200 mesh, pct | 100 | 25 | 45.0 | 25.5 | 68.0 | 61 | 24.7 | 49.5 | 46.3 | 66.6 |
| Pump, size | 2x2 | — | 6 in. B65 | 2 @ 2x2 | 4 in. | 4x6 in. | 4 in. | 4 in. | 6x6 in. | 4x6-6x8-5 in.-6x8 |
| Pump, rpm | 1190 | — | 950 | 1230 | 752 | 950 | 1002 | 967 | 830 to 890 | 985 810 950 690 |
| Pump, hp, actual | 2 | — | 25 | 10 | 15 | 15 | 20 | 15 | 24 to 24 | 20 30 40 30 |
| Pump, impeller, construction | Rubber | — | Rubber | Metal | Rubber | Rubber | Rubber | Ni-Hard | Iron-Iron | Rubber |
| Pump, impeller, life, days | — | — | 163 | 1000 | 600 | ? | 480+ | 365 | 95 to 95 | — |
| Pump, casing, construction | Rubber | — | Rubber | Metal | Rubber | Rubber | Rubber | Ni-Hard | Iron-Iron | Rubber |
| Pump, casing, life, days | — | — | 52 | 1000 | 600 | ? | — | — | — | — |

| | 20 In. | | | | | 24 In. | | 30 In. | |
|---|---|---|---|---|---|---|---|---|---|
| **Plant** | Silver Bell | Morenci | Copper Cities | Chino 1 | Chino 2 | Chino 3 | Cananea | Morenci | Morenci |
| **Circuit Position** | Primary Grinding | Regrind | Primary Grinding | Secondary Grinding | | Secondary Grinding | Primary Grinding | Regrind | Primary Grinding |
| Number in operation | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 1 |
| Cone angle, degrees | 15 | 20 | 15 | 20 | 20 | 20 | 20 | 20 | 20 |
| Cylinder length, in. | 0 | 17 | 24 | 24 | 24 | 24 | 16 | 24 | 24 |
| Feed inlet, sq in. | 21 | 39 | 19.64 | 27 | 27 | 52 | 36 | 54 | 85 |
| Vortex finder diam, in. | 8 to 9 | 7.0 | 6.75 | 7.5 | 7.5 | 7.5 to 8.5 | 6 to 8 | 7.5 | 7 |
| Apex opening, diam, in. | 3.5 | 3 | 4 | 6 | 6 | 6 to 7 | 4 to 5 | 4 | 5 |
| Cyclone make | Krebs | Morenci | Krebs | Chino | Chino | Chino | Galigher | Morenci | Morenci |
| Feed inlet pressure, psi | 3 | 10 | 7 | 12 | 12 | 12 | 5 to 7 | 10 | 10 to 15 |
| Feed volume, gpm | 1720 | 1530 | 1650 | 1512 | 1355 | 1735 | 1860 | 2025 | 1500 |
| Feed solids, pct | 59 | 15.5 | 55 | 51.3 | 51 | 56.3 | 54 | 15.0 | 55 |
| Feed tph, dry, new feed | 80 | 39.6 | 75 | 97 | 89 | 94 | 91 | 52.1 | 75 |
| Feed tph, dry, cyclone | 400 | 67.4 | 343 | 284 | 251 | 374 | 383 | 86 | 310 |
| Feed −200 mesh, pct | 19 | 56 | 12 | 28.9 | 32.0 | 24.5 | 20.2 | 51.0 | 20.9 |
| Overflow, volume, gpm | 870 | 1455 | 930 | 905 | 830 | 860 | 1020 | 1930 | 900 |
| Overflow, solids, pct | 30 | 10 | 27 | 34.0 | 34.0 | 34.2 | 29 | 10 | 28 |
| Overflow, tph, dry solids | 80 | 39.6 | 75 | 97 | 89 | 94 | 91 | 52.1 | 75 |
| Overflow, −200 mesh, pct | 54 | 84 | 48.7 | 59.0 | 61.0 | 59.2 | 58.8 | 75.0 | 59.3 |
| Underflow, volume, gpm | 850 | 75 | 720 | 607 | 525 | 875 | 840 | 95 | 670 |
| Underflow, solids, pct | 78 | 68 | 78 | 70.1 | 70.1 | 71.7 | 73 | 67 | 75 |
| Underflow, tph, dry solids | 320 | 27.7 | 268 | 187 | 162 | 280 | 292 | 34 | 235 |
| Underflow, −200 mesh, pct | 7.6 | 15.0 | 6.5 | 16.0 | 17.2 | 11.2 | 9.1 | 15.0 | 9.3 |
| Pump, size | 10x10 in. | Gravity feed | 8 in. | 8 in. | 8 in. | 8 in. | 8 in. | Gravity feed | 8 in. |
| Pump, rpm | 450 | | 535 | 765 | 785 | 785 | 530 | | 650 |
| Pump, hp, actual | 25 | | 75 | 70 | 83 | 83 | 87 | | 50 |
| Pump, impeller, construction | Rubber | | Metal | Rubber | Rubber | Rubber | Rubber | | Metal-Rubber |
| Pump, impeller, life, days | 142+ | | 20 | 75 | 75 | 75 | 40 to 50 | | 45 to 136 |
| Pump, casing, construction | Rubber | | Metal | Rubber | Rubber | Rubber | Rubber | | Rubber |
| Pump, casing, life, days | 300 (?) | | (?) | (?) | (?) | (?) | (?) | | 208 |

* Thick = removal of oversize from concentrate thickener feed.
** Regrind = open circuit desliming ahead of regrind circuit.

Recently a 30-in. cyclone has been replaced with two 20-in. Krebs cyclones with the principal object of reducing the feed inlet pressure required to produce the given size of classification. The reduced feed inlet pressure is presumed to lead to a lower pump speed, lower pump maintenance, and lower power requirements. Results of this test will be of considerable importance in cyclone design.

**Regrind Circuit Classification:** Various sizes of cyclones were built and tested in the regrind circuit of the Phelps Dodge Morenci concentrator over a period of years. By April 1955 each of the five regrind mills was equipped with a cyclone as the sole closed circuit classifier. The final installation consisted of three 30-in. and two 20-in. cyclones, together with gravity feed tanks and slide gates to control the feed volumes. The adoption of cyclone classifiers reduced the operating regrind mills used per mill day from 3.8 to 2.2, lowering steel and power requirements materially without any sacrifice in regrind product character.

Although no detailed maintenance figures are available, maintenance on cyclones and auxiliaries has been minor, and considerably less than with standard classifiers.

According to company reports, "Operation of the regrinding units with cyclone classifiers has proved to be quite easy." Feed volume is controlled by a sliding gate located in the feed line just ahead of the cyclone, and variations in underflow solids are compensated for by adjusting the size of the underflow spigot opening.

## Chino Mines Div., Kennecott Copper Corp.

Cyclones have been in use at the Chino concentrator since 1948, when the first model, a 3-in. diam unit, was tried. Cyclones at Chino have been tailored to particular jobs, for specific operating conditions. They have been used, generally, to supplement existing equipment or to improve efficiency.

Cyclones at Chino are being used or have been tried in the following places:

1) For auxiliary thickening, ahead of concentrate thickening, to handle fluctuating loads.

2) For classifying in the fine grinding circuit in place of bowl classifying. Classification generally was as efficient as the bowl, with a sharper separation at the limiting mesh, but it proved difficult to maintain constant feed to the cyclone.

3) For desanding milk of lime.

4) For emergency classifying of tailings at the disposal area to fill slime pockets in critical border areas or to back-fill against high winds.

At the present time Chino is actively testing cyclones in the following operations:

1) For classifying in the middling concentrate regrind circuit. At the present time a 16-in. cyclone is being tested pending installation of a regrind mill; advantage is being taken of scouring of tarnished particles with both products combined for flotation.

2) For classifying in the secondary grinding circuit. Cyclones are replacing existing drag and bowl classifiers and elevators and eliminating thickening of flotation feed. Feed to these cyclones is the product of the primary classifier overflow plus the discharge of the secondary ball mills in a pulp of 60 pct solids. Cyclone overflow at 34 pct solids was the flotation feed.

**Secondary Grinding:** All cyclones in use were made in the company shops of flanged bolted sections with spiral inlet of square cross section and were lined with three ⅛-in. layers of Linatex. No heavy wear is reported except at apex and vortex finder.

One 8-in. rubber-lined pump, driven at 765 and 785 rpm, supplied feed to these cyclones either directly or through a steady head tank. Impeller life is reported at 75 days; casing life has not been determined.

The operators use dilution water and feed tonnage regulation to control size of classification. Much less attention is required by these cyclones than the two-stage classification they replace; the company expects to replace all classifiers on secondary stage of fine grinding with cyclones. Noteworthy high-volume capacities (1355 and 1512 gpm for 20-in. cyclones) are obtained with these large spiral feed inlets (area = 27 sq in.) and high inlet pressure (12 psi) for this classification.

## Cananea Consolidated Copper Co., S. A.

Cyclones are currently being tested in one of the eight sections of the primary grinding circuit and have operated for almost two years in the regrind circuit at the Cananea Consolidated Copper concentrator at Cananea, Sonora, Mexico. In the primary grinding circuit, two 24-in. Galligher cyclones classify a spiral classifier overflow, returning sands to the ball mill and overflowing a finished product to flotation. The two 12-in. Dorrclones in the regrind circuit are operated in open circuit to remove coarse material from the primary rougher flotation concentrate for regrinding. Design and flow data are included in the attached tables.

**Comparison of Bond Classification Efficiencies for Various Cyclone Installations**

| Operation | Overflow +65, Pct | Overflow −200, Pct | Overflow Solids, Pct | Separation Size, μ | Bond Classification Efficiency, Pct | Cyclone Diameter, In. |
|---|---|---|---|---|---|---|
| Primary Grinding: | | | | | | |
| 1) Morenci | 9.2 | 59.3 | 29 | 122 | 72 | 30 |
| 2) Cananea | 17.2 | 56.8 | 29 | 186 | 78 | 24 |
| 3) Copper Cities | 18.8 | 40.7 | 25 | 205 | 80 | 20 |
| 4) Silver Bell-1 | 9.0 | 61.9 | 25 | 182 | 85 | 20 |
| 5) Silver Bell-2 | 23.5 | 40.4 | 40 | 229 | 78 | 20 |
| 6) Silver Bell-3 | 18.3 | 50.2 | 22 | 208 | 83 | Spiral Classifier |
| Secondary Grinding: | | | | | | |
| 1) Chino-1 | 8.2 | 59.0 | 34 | 127 | 75 | 20 |
| 2) Chino-2 | 7.0 | 61.0 | 34 | 111 | 74 | 20 |
| Regrinding: | | | | | | |
| 1) Cananea | 0.4 | 91.6 | 15 | 34* | 73* | 12 |
| 2) Copper Cities | 0.2 | 91.2 | 15 | 34* | 70* | 10 |
| 3) Silver Bell | — | 93.0 | 20 | 38 | 62 | 12 |
| Others: | | | | | | |
| 1) Copper Cities —Lime | 0.8 | 80.7 | (25) | 69 | 77 | 10 |
| 2) Silver Bell —Tailing Dam | 5.0 | 67.0 | 41 | 58 | 62 | 10 |

* Figures derived from curves extrapolated from −200 mesh.

The separation size in microns as given in this table is that size at which the weight percentage plus in the underflow is the same as the weight percentage minus in the overflow. For instance, a plot of cumulative percent weight plus for cyclone underflow and cumulative percent minus for cyclone overflow, with screen size as one coordinate and cumulative percent weight as the other, results in two curves which have one point in common. The coordinates of this point as read from size and percent axes are the separation size and classification efficiencies given.

The other information given in the table has not been included for the purpose of explaining high or low results, but for the purpose of identifying the type of classification involved.

The primary circuit cyclones have operated about four months and no wear is reported on cyclones proper. The impeller life of the 8 x 10-in. rubber-lined pump (driven at 530 rpm) feeding these cyclones is listed at 40 days. Casing life has not been determined.

On the regrind cyclones the overflow discharge elbow is reported as the main wear point. No rubber-lined parts have been replaced, and slight wear is reported on the feed inlet. The two 6-in. Wilfley pumps that feed these cyclones are equipped with iron impellers and casings. Impeller life is at 95 days.

Points of interest on the primary cyclones are the pump box design, which allows recirculation of cyclone overflow and prevents surging, and the use of the Littlewood controller, which automatically controls the mill feed. The operators state that very high circulating loads make this circuit difficult to operate as compared to the standard mill-spiral-classifier circuit.

The apex valve adjustment on the regrind circuit cyclones is listed as the only operating variable; otherwise no particular attention is given these cyclones.

## A Southwestern Copper Concentrator

Another southwestern concentrator uses four 12-in. rubber-lined Dorrclones to deslime ahead of regrind in order to reduce the volume to spiral classifiers and thus obtain a finer overflow. Design and flow data may be found in the attached tables.

Most of these cyclones have been in service somewhat less than one year, and the only parts thus far run to destruction are the vortex finders and overflow ells. No accurate data on the life of these parts is available, but indications are that it is fairly long.

## Screen Sizings of Cyclone Products, Cumulative Weight Percent Plus

| Name | MORENCI | | | | | | | | | CHINO | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Circuit Position | Primary Grinding | | | Regrind—Original | | | Regrind—Extension | | | (1) Secondary Grinding | | | (2) Secondary Grinding | | |
| Mesh | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow |
| 65 | 54.8 | 68.1 | 9.2 | — | — | — | — | — | — | 39.5 | 56.8 | 8.2 | 32.8 | 46.0 | 7.0 |
| 100 | 67.1 | 79.9 | 21.5 | — | — | — | — | — | — | 53.3 | 70.0 | 19.8 | 48.4 | 64.8 | 17.7 |
| 200 | 79.1 | 90.7 | 40.7 | 72.0 | 60.0 | 6.0 | 25.0 | 55.0 | 4.0 | 71.1 | 84.0 | 41.0 | 68.0 | 82.8 | 39.0 |
| 325 | — | — | — | 49.0 | 85.0 | 25.0 | 44.0 | 85.0 | 16.0 | — | — | — | — | — | — |
| Pan | 20.9 | 9.3 | 59.3 | 51.0 | 15.0 | 75.0 | 56.0 | 15.0 | 84.0 | 28.9 | 16.0 | 59.0 | 32.0 | 17.2 | 61.0 |

| Name | CANANEA | | | | | | Southwestern Concentrator | | |
|---|---|---|---|---|---|---|---|---|---|
| Circuit Position | Primary Classifier | | | Regrind, Open Circuit | | | Regrind, Open Circuit | | |
| Mesh | Feed | Underflow | Overflow | Feed | Underflow | Overflow | Feed | Underflow | Overflow |
| 65 | 59.8 | 73.6 | 17.2 | 6.7 | 10.6 | 0.4 | — | — | — |
| 100 | 71.1 | 84.6 | 27.6 | 15.7 | 26.7 | 1.7 | — | — | — |
| 200 | 79.8 | 90.9 | 41.2 | 32.0 | 53.7 | 8.4 | 22.7 | 33.4 | 4.5 |
| 325 | — | — | — | — | — | — | 47.8 | 66.4 | 16.6 |
| Pan | 20.2 | 9.1 | 58.8 | 68.0 | 46.3 | 91.6 | 52.2 | 33.6 | 83.4 |

| Name | MAGMA | | | | | | | | | COPPER CITIES | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Circuit Position | Regrind | | | Smelter Flux | | | Conc. Thickener | | | Regrind | | | Lime Circuit | | |
| Mesh | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow |
| 65 | — | — | — | — | — | — | — | — | — | 6.2 | 9.3 | 0.2 | 13.8 | 19.6 | 0.8 |
| 100 | — | — | — | 10.8 | 44.6 | 9.5 | 13.8 | 50.5 | — | 15.1 | 24.4 | 0.7 | 31.2 | 44.0 | 4.1 |
| 200 | 18.0 | 32.0 | 4.7 | 29.4 | 75.3 | 27.6 | 31.8 | 76.6 | 5.9 | 39.1 | 55.0 | 8.8 | 56.9 | 74.5 | 19.3 |
| 325 | 49.0 | 74.3 | 24.7 | — | — | — | — | — | 20.9 | — | — | — | — | — | — |
| Pan | 51.0 | 25.7 | 75.3 | 70.6 | 24.7 | 72.4 | 68.2 | 23.4 | 79.1 | 60.9 | 45.0 | 91.2 | 43.1 | 25.5 | 80.7 |

| Name | COPPER CITIES | | | SILVER BELL | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Circuit Position | Primary Grinding | | | Primary Grinding | | | Regrind | | | Tailings Dam | | | MoS2 Regrind | | |
| Mesh | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow | Feed | Under-flow | Overflow |
| 65 | 71.8 | 79.9 | 18.8 | 60.0 | 74.0 | 15.0 | 7.5 | 10.0 | — | 11.0 | 27.0 | 5.0 | — | — | — |
| 100 | 80.3 | 87.5 | 33.2 | 70.0 | 84.0 | 28.0 | 14.0 | 18.0 | 0.5 | 23.0 | 46.0 | 16.0 | 0.3 | 0.4 | — |
| 200 | 83.0 | 93.5 | 51.3 | 81.0 | 92.5 | 46.0 | 31.0 | 39.0 | 7.0 | 41.0 | 58.0 | 33.0 | 0.9 | 1.3 | — |
| 325 | — | — | — | — | — | — | 58.0 | 72.0 | 16.0 | 52.0 | 65.0 | 46.0 | 5.6 | 8.3 | 0.2 |
| Pan | 12.0 | 6.5 | 48.7 | 19.0 | 7.5 | 54.0 | 42.0 | 28.0 | 84.0 | 48.0 | 35.0 | 54.0 | 94.4 | 91.7 | 99.8 |

The operator considers complete rubber lining necessary.

Four separate pumps of different styles supply feed to the cyclones. All are rubber-lined. As yet no data is available on part life.

The operators control the cyclone feed volume by regulation of the amount of froth pulled in flotation and by manual addition of water. Classification size is controlled by apex valve variation and limited dilution. In contrasting the requirements of cyclones with those of conventional classifiers, the operator points out the necessity of pump maintenance and of reasonably constant feed control.

An interesting comment was offered on the differential classification of sulfide and gangue particles encountered with these cyclones, attributed to the sink-float effect in which fine pyrite acted as a heavy media towards coarse gangue. The operators state that in one test the overflow sulfides were 99 pct −200 mesh, while the overflow gangue contained 85.6 pct −200 mesh. The underflow recovered 99 pct of the +200 mesh sulfides and 66.6 pct of the +200 mesh gangue. The percent of oversize gangue lost in the overflow was 37 times the percentage loss of oversize sulfides. In numerous other tests, underflow recoveries of +65 mesh gangue were lower than underflow recoveries of +150 mesh sulfides. Since considerable copper was associated with the gangue, this effect was not beneficial and was partially overcome by higher feed inlet pressures.

### Pima Mining Co.

The first mill in Arizona to be built with cyclones as the only primary grinding circuit classifiers is the Pima Mining Co. concentrator 20 miles south of Tucson. Although this mill is not yet in operation, the installation is certainly of interest, and it is hoped that operating data will be available. This primary grinding circuit is reported to consist of:

1) One 10x12-ft rod mill expected to overflow essentially −10 mesh material.

2) Two 10½x12-ft overflow-type ball mills, which are to receive a variable portion of the rod mill discharge directly.

3) Six 20-in. Krebs cyclones (three for each mill), which are to be fed by two of four all-metal pumps. These cyclones receive part of the rod mill discharge, as well as the ball mill discharge, and necessary dilution water. Cyclone underflow is returned to the ball mills, and overflow to flotation.

**Spiral Classifier Data for Primary Grinding Circuit**

| Screen Mesh Fraction (Tyler) | Percent of Total Pyrite in Classifier Feed Reporting to: Classifier Sand | Classifier Overflow |
|---|---|---|
| −35, +48 | 92 | 8 |
| −48, +65 | 88 | 12 |
| −65, +100 | 86 | 14 |
| −100, +150 | 77 | 23 |
| −150, +200 | 73 | 27 |
| −200 | 37 | 63 |

Differential Grind Data for Primary Grinding Circuit at Silver Bell

| Screen Mesh Fraction (Tyler) | Wt, Pct | | Sulfur, Pct | |
|---|---|---|---|---|
| | Cyclone Overflow | Spiral Classifier Overflow | Cyclone Overflow | Spiral Classifier Overflow |
| +35 | 2.5 | 1.4 | 0.54 | 3.72 |
| −35, +48 | 7.4 | 6.7 | 0.52 | 2.58 |
| +48, +65 | 10.9 | 12.5 | 0.66 | 2.42 |
| −65, −100 | 12.4 | 14.1 | 1.58 | 2.96 |
| −100, +150 | 8.4 | 9.0 | 3.50 | 3.57 |
| +150, +200 | 8.9 | 9.5 | 5.20 | 4.19 |
| −200, +325 | 11.2 | 11.1 | 5.61 | 3.67 |
| −325, +20M | 7.1 | 5.6 | 6.24 | 4.93 |
| −20M | 31.2 | 30.1 | 1.63 | 1.09 |
| Head | 100.0 | 100.0 | 2.66 | 2.67 |

Enough floor space has been provided for later installation of conventional classifiers in case the rod and overflow mills do not provide the necessary pump protection from tramp oversize. Cyclone feed pumps are reported to be of all-metal construction.

**Regrind Circuit:** Scavenger concentrates and cleaner and recleaner tailings are to be reground by a 7x12-ft ball mill in closed circuit with 10-in. Krebs cyclones.

## Magma Copper Co.

Cyclones are used in the Magma Copper Co. mill at Superior, Ariz., in three different flowsheet positions. Four 10-in. cyclones are in service as closed circuit classifiers in the rougher concentrate regrind section; one 12-in. cyclone is used to supply +65 mesh silica flux for the smelter; one 12-in. cyclone removes coarse material from the copper concentrate thickener feed and underflows this material into the concentrate filter. All these cyclones have been constructed in the company shops with rubber-lined cones. Design and flow data are given in the accompanying tables.

The number of cyclones operated (regrind circuit), dilution water, and apex orifice size are the operating controls used. Except for removal of wood pulp from the ⅝-in. orifice on the silica flux cyclones little or no operating attendance is required.

**Regrind:** After about three years of operation, wear is reported only on the 2-in. feed jets and mill steel inlet manifold. The 4-in. feed pump rubber casing and impeller life has been 20 months.

**Silica Flux:** Here the cyclone has operated 2½ years. Main wear points have been reported on splash head and feed cylinder, both of which are to be rubber-lined in future. No new parts have been installed on the 4-in. rubber-lined feed pump after 16 months operation.

**Concentrate Thickener:** This cyclone has been in operation since April 1954. No parts have been replaced. The 4-in. Ni-Hard feed pump impeller life is given as one year.

## Copper Cities Div., Miami Copper Co.

Cyclones are presently in use at the Copper Cities concentrator as regrind and lime circuit classifiers and as test units in one section of the primary grinding circuit. The tables at the end of this paper show design and flow data for these circuits.

**Regrind:** Four 10-in. Krebs cyclones were installed in this circuit at the end of March 1957. No data is yet available on the wear life of cyclones proper. A mild steel manifold that distributed feed to the regrind cyclones was worn out in 117 days and is being replaced with a rubber-lined manifold. Various pipe bends in this circuit are changed at 60-day intervals. A shell liner life of 52 days and an impeller life of 163 days is reported on the 6-in. rubber-lined pump supplying feed to these cyclones.

**Lime:** No significant wear is reported on parts of the lime circuit cyclones, pumps, or lines since their installation in July of this year.

**Primary:** A preliminary report on the 8-in. all-metal pump feeding the three cyclones in the primary grinding circuit shows a wear life of 20 days for the impeller. It is understood that the operators intend to test a rubber-lined pump in the near future.

**Operating Attendance:** The operators state that the apex spigot size is the principal classification control on all cyclones and that very little operating attention is required.

**Feed Volume Control:** Cyclone feed volume control is obtained by controlling the amount of froth pulled from the flotation section into the regrind circuit, by controlling the raw lime and water additions in the lime circuit, and by a slide gate in the feed sump of the primary circuit.

**Differential Classification:** Distribution of insoluble content of the final concentrate shows an increase in coarse sizes since cyclones were put into operation in the regrind circuit. Copper mineral in the primary circuit cyclone overflow shows a tendency to concentrate in the finer size ranges.

## American Smelter & Refining Co. Unit at Silver Bell, Ariz.

Cyclones are being used in the Silver Bell Concentrator in the four flowsheet positions:

**Regrind Circuit Cyclones:** Cyclones were included in the original mill design as closed circuit classifiers for the rougher concentrate regrind section. Regrinding is accomplished in two 7x12-ft overflow-type ball mills, using 1-in. and 1¼-in. grinding balls. Each of these mills is equipped with two 12-in. by 20° Dorrclones and two rubber-lined pumps connected into one sump at the discharge end of each ball mill. Normally one pump-cyclone unit per mill is operated, the other serving as a standby unit. The rougher concentrate from the flotation section is pumped first into a 26-ft diam hydroseparator. The underflow from this unit is metered by a duplex diaphragm pump into the cyclone feed sumps; together with the ball mill discharge, this new feed is pumped into the cyclone in use for that particular mill. The cyclone overflow is recycled in part to the cyclone feed sump. That part of the overflow which is not used in keeping a steady head in the feed sump joins the hydroseparator overflow on its way to the cleaner flotation section of the plant.

These cyclones are operating with practically no attention other than periodic adjustment of underflow apex valves. They supply a 300 to 500 pct circulating load to the mills, while overflowing a finished product containing 85 to 90 pct −325 mesh material. Maintenance cost on cyclones proper has been negligible. Pump impeller life has been about 2½ months and casing life 3 months.

**Tailings Dam Cyclones:** About one year after the start of operations six 10 in. x 15° Krebs cyclones were installed at the tailings dam. The cyclones are gravity fed from the main tailings line, taking about one quarter of the total volume of tailings pulp. Since installation they have provided all of the required material for berms at what is believed to be an extremely low cost in comparison to alternate methods of constructing berms.

**Cyclones were included in the original design of Asarco's 7500-ton Silver Bell concentrator. The plant, shown above center, uses units as closed circuit classifiers for the rougher concentrate regrind section.**

In two years of operation, (classifying more than 1 million tons of solids) no parts have been replaced on the cyclones; it appears that several additional years of operational life remain in the rubber linings. Operating attendance is limited to adjustment of the tilt angle of the cyclones to obtain the desired underflow density. After they are once set, only major changes in feed density or pressure require further changes in this angle setting.

**Molybdenite Section Cyclones:** In April 1956, two 3-in. x 20° Dorrclones were installed in closed circuit with a 3x4-ft overflow-type regrind mill in the molybdenite section of the concentrator. Although only one cylcone is required for this service, duplicate pumps and cyclones were installed for standby purposes. This 3-in. unit provides a contrast to the volume and service performed by other units in that it handles only about 12 gpm of feed and overflows about 5 tons per day of −400 mesh solids, while providing a 200 pct circulating load for this small regrind mill. Further details are given in the attached tables.

**Primary Grinding Test Circuit Cyclones:** On July 10, 1956, the testing of cyclones in the primary grinding circuit was started. The test circuit consists of a 10½x12-ft a-c grate discharge mill, one 78-in. duplex Akins spiral classifier, one 10x10-in. Linatex horizontal slurry pump, and three 20-in Krebs cyclones.

The cyclones receive the spiral classifier overflow at 55 to 65 pct solids, returning sands to the ball mill and overflowing a finished product to flotation. The spirals are operated at 4 rpm and are approximately one-quarter loaded in elevating the Akins sands to the mill scoop box.

These cyclones were installed with the following objectives: First, they were expected to produce a flotation feed of approximately the same solids size distribution as the rest of the mill classifier circuits, but at a considerably higher solids to water ratio, thus providing as much as 50 pct more flotation time in the rougher circuit. The results of many laboratory scavenger flotation tests on rougher tailings consistently have shown additional copper recovery. Second, following the trend shown at Morenci, flotation feed provided by cyclone classification was expected to show a much finer sulfide particle size at the same overall grind than that obtained from conventional rake or spiral classifiers. This *differential grinding* was expected to aid in rejection of clean pyrite in the rougher circuit and possibly increase copper recovery at the same overall grind. Third, this installation, handling up to 2000 tpd in a parallel but isolated section, was expected to provide operational and maintenance data that could be translated directly to the three other sections of the concentrator if this seemed warranted at the conclusion of testing.

**Cyclone Data for Primary Grinding Circuit at Silver Bell**

| Screen Mesh Fraction (Tyler) | Percent of Total Pyrite in Cyclone Feed, Reporting to: Cyclone Overflow | Cyclone Overflow |
|---|---|---|
| −35, +48 | 99 | 1 |
| −48, +65 | 99 | 1 |
| −65, +100 | 98 | 2 |
| −100, +150 | 95 | 5 |
| −150, +200 | 86 | 14 |
| −200 | 60 | 40 |

Operation of the test circuit to date has answered many questions and at the same time raised a few new ones. The cyclone-pump unit has operated satisfactorily for more than four months at a lower power cost than anticipated and at such low maintenance cost that it will take some months to deter-

The authors estimate that about 100 cyclones are in use in Arizona plants such as Miami Copper Co.'s Copper Cities concentrator, shown here. Most of the units have been put into operation within the last three years.

mine the ultimate life of cyclone and pump parts. The cyclones have provided the expected additional flotation time by producing a higher flotation feed density, and there is striking evidence as to the differential grinding of sulfides obtained through the use of cyclones.

Surprisingly, however, the increased flotation time did not lower the rougher tailing copper content, hundreds of laboratory scavenger tests to the contrary. Further, although there is every evidence of increased pyrite rejection in the rougher circuit, apparently little or no new copper is unlocked and floated due to this finer sulfide grind. The possible benefits to be derived in the regrinding and cleaning sections of the plant from this differential grinding are very difficult to demonstrate conclusively under the test conditions.

With the foregoing results as a background, the following possibilities remain:

1) That the cyclone unit will show a metallurgical advantage at a finer grind than is now standard for the mill as a whole. Results of previous mill tests (without cyclones) on finer grinds have been inconclusive. While there may be little or no advantage in the additional flotation time secured by raising the flotation feed density from 22 to 30 pct solids, there might be an advantage when the range considered is from 17 pct using spiral classifiers to 26 pct solids using cyclones, as would be the case if finer grinding were considered. Current plant testing indicates that some benefit is being obtained, although tests will not be completed for some months to come.

2) That the pump-cyclone unit will do an equivalent closed circuit classification job at a lower overall operating and maintenance cost. Although originally this was not seriously expected, figures on hand to date indicate that the cyclone vs spiral classification cost will be much closer than anticipated. However, other considerations will have to justify converting the rest of the grinding section, if this is done at all.

3) That in consideration of any new grinding installation, the lower initial cost and smaller building requirements might swing the decision in favor of the straight cyclone circuit, or to a combination circuit with a much smaller classifier. The spiral classifier function of *detramping* the cyclone pump feed has not yet been eliminated, but with the encouraging data on pump and cyclone wear life, it is believed that a machine less bulky and costly than the present classifiers might provide the necessary pump protection.

## Summary

In summary, it might be said that out of seven possible classification applications in the Silver Bell concentrator, cyclones are operating satisfactorily in four, are being actively considered for a fifth (lime plant), and might have been a more economical installation in the other two, had sufficient information been on hand to warrant their installation in these positions originally (regrind and tailings hydroseparators.)

The four examples given illustrate their versatility in tonnage (5 to 2000 tpd) and classification range (from a top size of 28 mesh to 400 mesh). With regard to ease of operation it has been found in three cases that less attention is required than would be expected with other methods of classification. In the fourth case (primary grinding circuit) the operation of two stages of classification in order to close the circuit on coarse material has required some additional attention. However, even in this circuit, there have been no difficulties in controlling the circuit with the same operating force.

# Safety Engineering At Alabama Coal Mines

***With the coming of mechanization, safety engineering jobs have grown. New layouts have been made and cleaning plants modernized. In some cases the whole system of mining has been changed.***

by Lawrence Henderson

TO increase tonnage in the early days of coal mining it was necessary only to hire more men. The job now is to increase the tons per man, but other troubles arise because this has been accomplished. With the introduction of continuous miners, newer and faster loading machines, and faster belt conveyors the safety engineer has been faced with new difficulties.

Use of larger equipment created roof control problems, which were thoroughly studied by the safety engineers of various companies. With the assistance of the U. S. Bureau of Mines, safety engineers in Alabama conducted roof bolting experiments wherever they appeared to be applicable. Accident records before and after the method was adopted showed results more than justifying the efforts and funds expended. The larger mining companies responded enthusiastically to the program because roof bolting not only prevented accidents but also increased production efficiency, in many cases representing the margin between profit and loss. In Alabama today there are miles of roof supported by bolts.

**Control of Airborne Dust:** Operation of modern mining equipment—the continuous miner in particular—raises dust that is carried in the air and deposited in worked out places. Coal seams in Alabama, especially thick coal beds, contain various partings and in some instances slate. The combination of parting dust and coal dust suspended in the atmosphere presents a more complicated problem than coal dust alone. Alabama coal companies have experimented with several types of water sprays under different pressures, using different wetting agents, but still have not found the answer. The problem will not be solved until dust can be wet the very instant it becomes suspended, or before. It has been found almost impossible, once the dust is airborne, to take it directly out of the air or to control it by sprays using any wetting agent. There is no dust problem with roof bolting because water or dust collectors are used on the roof bolting drills.

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There are two or more ways to measure dust concentrations. One is the generally accepted impinger method. A second procedure employs the electronic dust counter, now being tested by the government and soon to be used in Alabama. The silica content in dust is determined by chemical analysis or by X-ray diffraction.

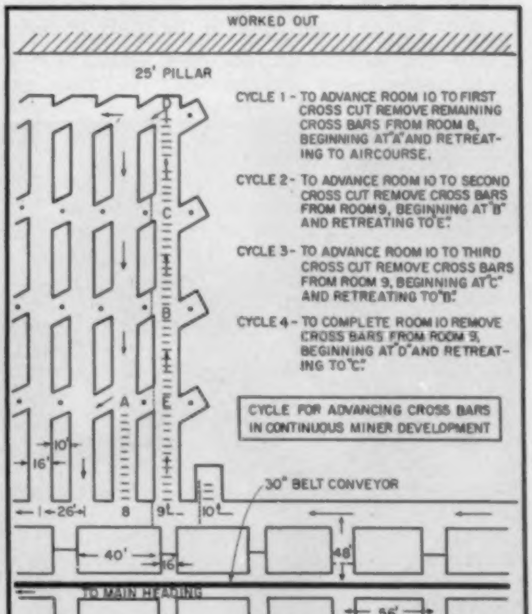
In mechanized mines where the working faces advance more than 40 ft per shift, rock dusting near the active faces during the loading shift is a health hazard. In many Alabama mines wetted rock dust is now being applied on the roof and ribs and dry dust on the bottom, but it remains to be seen whether this will be the answer. It is possible that after the wetted dust has dried, enough fine

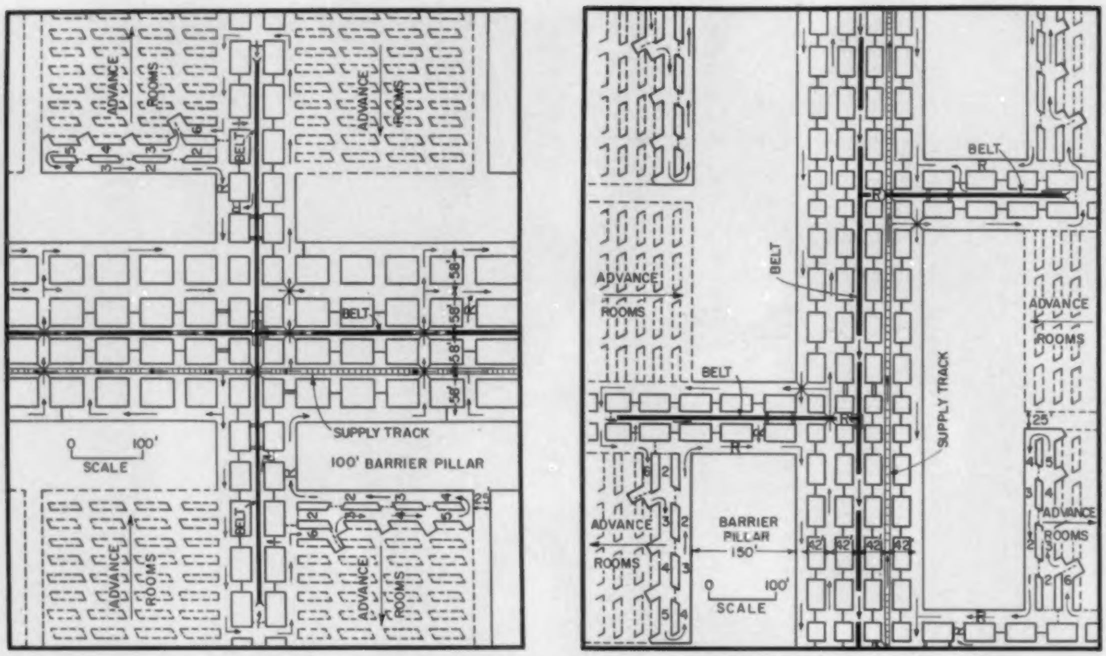
Fletcher roof bolting machine—one of several types of rotary drills used for installing rock bolts.

coal dust will accumulate on this surface to propogate an explosion.

**Mine Ventilation:** To keep up with the rapid advance in mechanized mining, ventilating systems have had to be changed, especially where continuous miners drive places 125 to 175 ft per shift. Most mines have installed more fans, ventilating each section on a separate air split. In Alabama ventilation surveys are made in the mines by company and state inspectors, who then draw up reports. It is required that all fans be provided with a pressure recording gage and an automatic device to give alarm when the fan slows down or stops. An engineered ventilation return system is used in some of the mines—with other systems it has been possible to eliminate all doors on the main haulage. To keep fumes away from the faces in case of a belt fire, many sectional conveyor belts are placed on a special return split of air.

**Safe Operation of Equipment:** The buyer is interested in equipment that will give him the fastest possible coal extraction with minimum production cost and labor, as well as maximum safety for operators and men working nearby. Personnel must be trained to operate and maintain this new equipment, and schools taught by factory engineers have been started at Alabama plants. At one of the largest coal producing mines in the state, during the miners' vacation each year, su-





**Development and ventilation systems used in an all-belt mine.**

pervisors attend a two-week school where safety, production, and maintenance are taught. At another large mine a school of engineering is now in progress. The company supplies an instructor, pays the cost of the complete I. C. S. course, and pays the men for the time spent in school.

Effective means of frame grounding and improved power trailing cables have been installed. The new safety sentinel ground circuit is in use and everything known at this time has been added to insure safety to operators of this equipment. Progress is also being made in the study of underground illumination.

In the last few years great advances have been made in wearing protective clothing. Men engaged in haulage operations are required to wear snug-fitting clothes. Safety shoes and safety hats are a must, and goggles are worn when needed. Some companies supply the goggles; others require the men to buy them. Respirators are furnished when necessary.

Since the revision of Alabama laws, only permissible explosives or permissible blasting methods can be used to blast coal or other materials on shift, although under certain conditions a few small mines are still allowed to use black powder.

**Modern Alabama cleaning plant which will help supply the Nation's 1957 estimated 1.52 billion tons of coal.**

To keep up with the rapid advance in mechanized mining, ventilating systems have had to be changed, especially where continuous miners drive places 125 to 175 ft per shift.

The 24-in. stick permissible powder is now used extensively in Alabama. Only electric detonators of proper strength are allowed. Delay electric detonators are prohibited.

**Protection Against Fire Hazards:** With the coming of mechanized equipment there were greater fire hazards. More lubricants were carried underground. Conveyor belts were installed, and this in itself created the most dangerous of mine fire hazards, especially when the belts were combustible. All Alabama mines, except those referred to as *push* or *wagon* mines, are adequately supplied with underground fire-fighting equipment. Fire drills are held and equipment is checked periodically. Water, rock dust, and different types of extinguishers are available, and some mines have track-mounted fire trucks that are also equipped with rubber-tired portable trucks. There have been no disastrous mine fires in the state for a number of years.

**Improved Surface Facilities:** Surface facilities at Alabama coal mines have been greatly improved in the last ten years. The old catwalks without handrails have been replaced by stairways, elevated platforms, and runways that have handrails and, where necessary, toeboards. Good housekeeping is practiced. Engineered lighting systems are set up, fire-fighting equipment is conveniently located, and electric motors in dusty locations are of dust-tight construction. Sanitary bath houses are provided. In electric and maintenance shops floors are kept clean and walkways clear.

**First Aid Training:** The large coal companies of Alabama believe that the health and safety of men working in their mines is the primary responsibility of the operator. First Aid classes are conducted, First Aid teams are trained for national competition, and in some mines there is 100 pct First Aid training. All companies have mine rescue equipment and many hold classes in mine rescue techniques, taught by the USBM or by company safety engineers. Classes taught by company personnel are examined by USBM representatives after the men complete the course. Refresher courses are held twice a year, and accident prevention courses are taught by the USBM, which has rendered the mining industry of Alabama a true service in developing and disseminating improved techniques of accident prevention and in recognizing company efforts by granting awards for outstanding performance. Because this important work deserves support, the Holmes Safety Assn. has been organized in Alabama and is doing an excellent job in helping to prevent accidents and promote better understanding between labor and management. Safety problems are discussed at monthly meetings. The companies maintain bulletin boards on which accident records are listed, displays up-to-date posters in conspicuous places, presents motion pictures, and sponsors underground safety meetings, which are set up and handled by company safety departments. Once or twice a month, depending on the company, safety meetings are held with all supervisors.

It is estimated that in 1957 the nation's demand for coal will exceed 1.52 billion tons. New extensive fields for mining coal are being explored every day in Alabama. The safety engineers have come a long way in the last ten years, but their goal has not yet been attained. New problems will arise every day while they are still trying to solve the old ones. Laws and regulations, protective devices, and safe working places are all valuable and necessary, but these in themselves will not eliminate preventable accidents in coal mines. It is people who are injured, and it is with people that safety engineers must deal.

# Nature and Origin of Southwestern Oregon Chromite Deposits

by Len Ramp

CHROMITE deposits in southwestern Oregon occur along definite zones or horizons in sill-like ultramafic intrusions. These horizons are here referred to as *ore zones* and are distinguishable only by relatively thin and scattered, discontinuous chromite occurrences. The zones are tabular in shape but are usually folded and faulted by the intensive post-intrusion deformation the ultramafic rocks have undergone. A single zone may contain disseminated, nodular, banded, or pods of massive chromite. The typical chromite deposit is composed of a series of thin lens-shaped bodies that lie along a definite plane and generally show evidence of magmatic flow with their long dimensions aligned in the direction of flow. A body of chromite often pinches down to a narrow wisp only a fraction of an inch thick. This thin streak of chromite may point to or be connected with another body of chromite. In some deposits the orebodies have a definite rake. The depth at which chromite may be found can be predicted by its position in a folded intrusive, provided that adequate structural evidence is available. Although the ore shoots are characteristically discontinuous, there is theoretically no limit to the depth at which chromite may be found.

**Origin:** All the chromite deposits examined in southwestern Oregon are of magmatic origin, that is, the chromite was an original constituent of the peridotite magma and became segregated in varying degree from the magma to form the ore deposits. Examples of early, intermediate, and late magmatic chromite have been recognized in the area. Crystallization of the principal minerals (olivine, pyroxene, and chromite) was apparently near completion at the time of intrusion of the peridotite magma. The magma acted as a viscous crystal mush stringing out aggregates of pyroxene and chromite in the direction of flow. These streaky accumulations are termed *schlieren*.

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**Structural Varieties:** Different structural varieties of chromite attest to a variation in genesis. Four different varieties—disseminated, nodular, banded, and pods of massive ore—are recognized in the area.

Disseminated: Evenly scattered disseminated grains of chromite in dunite demonstrate lack of segregation. Crystallization of the magma had probably advanced to a point where the heavier chomite grains were unable to accumulate by settling.

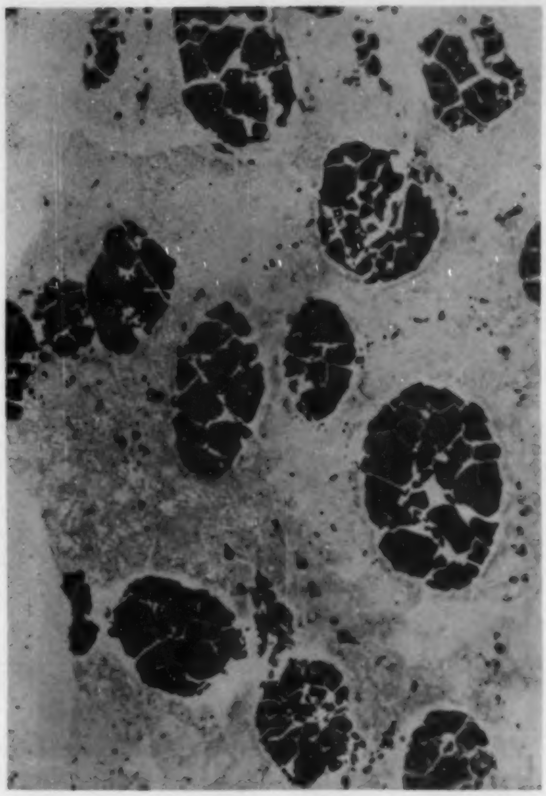
Nodular: Nodular chromite consisting of aggregates of spherical or ellipsoidal chromite as much as ¾ in. diam disseminated in the dunite or serpentine occurs at several places in the area. Those examined appear to have been large, probably euhedral crystals of chromite that have been rounded by abrasion and/or re-solution. Kromer[1] advanced such a theory for the origin of nodular chromite in Turkey. Subsequent movement of the magma or movement of the rock during serpentinization or other deformation has resulted in crushing of the nodules. The fractures are healed serpentine or chlorite.

Banded: Banded chromite is fairly common. Both planar and linear-banded chromite are found but the planar-banded or layered ore is more frequently seen.

Planar bands of chromite are formed as layers by means of gravitational settling of chromite crystals onto a horizontal floor of olivine and/or pyroxene crystals. Periodic crystallization of chromite, in a system where the crystallization of olivine is more or less continuous, is the most logical explanation for the formation of a series of closely spaced chromite layers. Subsequent movement, whether magmatic flow or other deformation, has usually erased good evidence of layering.

At the Lower Violet mine on Chrome Ridge the thin closely spaced layers of chromite in altered dunite strike north and have a nearly vertical dip.


**Layered chromite exposed in vertical north wall of glory hole at Lower Violet Mine. Note composite nature of layers and gradational west edges. Layers strike N 10°E and dip 85°E.**



**Micrograph of thin section of nodular chromite in serpentine from Shade Mine Illinois River district, Josephine County, (X4, largest nodule is 0.3 in. long). Note *halos* of chromite fragments and *sheaths* of chlorite surrounding nodules.**

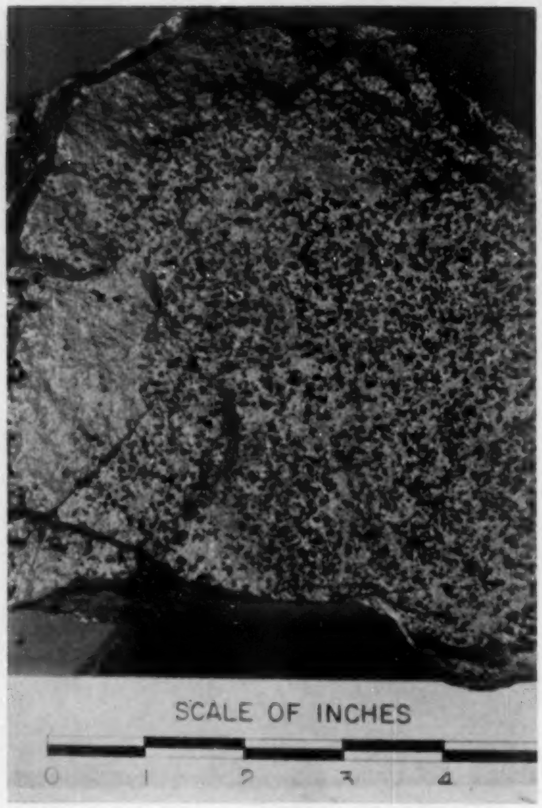
Their eastern edges, interpreted as the base, are consistently fairly sharp while the western edges, or tops of the layers, grade into almost barren dunite. The chromite crystals are slightly larger and more closely spaced near the base of the layers. It is believed that precipitation of the chromite in such a system begins more rapidly than it ceases. A sensitive balance due to a deficiency in the magma of one or more of the essential oxide components of chromite is suggested as an explanation for the intermittent manner of chromite crystallization. The banded structure suggests that the magma became saturated periodically with chromite. Crystallization of chromite was then triggered by some upset of the balance. Rapid crystallization would soon use up the necessary but deficient oxide or oxides, causing the precipitation to taper off until the supply could again build up to a point where the cycle is repeated.

Linear-banded ore is characterized by rod-shaped schlieren of chromite which show lineation in one direction only. Observed examples of linear banding can be explained by directional flowage following accumulation of chromite to form a scattering of aggregates, clots, nodules, or orbicules. A sample of nodular chromite partially strung out to form linear-banded structure by flowage or shearing was found at the Gray Buck deposit in the Illinois River district.

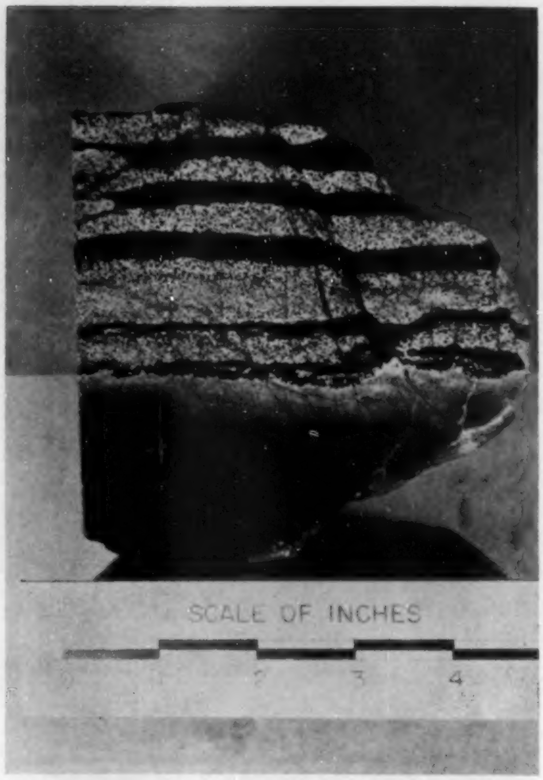
Massive: Pods of massive chromite have been found in various shapes. The most common are roughly elliptical in plan and lenticular in section. Others are ellipsoidal. Irregularly shaped bodies of massive chromite with sharp angular boundaries have also been observed. These angular pods of massive ore are believed to have been segregated at depth by early crystallization and settling of chromite into a solid mass. Subsequent intrusion of the peridotite magma resulted in breaking up these chromite layers or solid pool-shaped masses into angular segments. The liquid magma then filled fractures in the chromite and crystallized.

Ellipsoidal and lens-shaped pods of massive chromite are often found in highly sheared and altered serpentine, sometimes referred to as *slickentite*, a coined name for pulverized, fish-scalelike serpentine. The movement necessary to produce slickentite is undoubtedly responsible for the resultant lens shape of the chromite pods. Fragments of crushed chromite can generally be found tailing off into the serpentine from the larger hard body of chromite. These tails of crushed chromite may lead to other pods of ore. Fairly large and massive chromite schlieren may have formed by the breaking up of a chromite layer and its stringing out during the intrusion of magma while in the crystal mush stage.

The basic form achieved in the more complete stages of segregation of massive chromite appears to be the layer. It may form as a single layer or multiple layers. Slow cooling and therefore slow crystallization of the magma which may take place at great depths and under stable conditions is believed conducive to the formation of thick and massive layers or *pools* of chromite crystals. The larger massive bodies of chromite, as at the Oregon Chrome mine (Oregon's largest chromite producer) where lenses as much as 15 ft thick occur, were




Disseminated chromite in dunite from Horse Mountain, Illinois River district, Josephine County.




Planar-banded, disseminated chromite from Chrome Ridge, Josephine County. Note evidence of flowage.

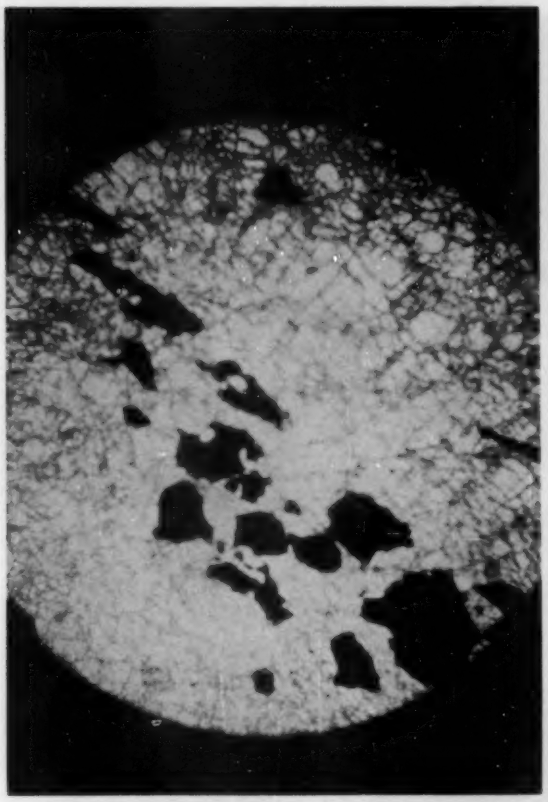
probably formed under such favorable conditions. At this mine the chromite apparently has suffered less thinning during intrusion and deformation than at other points along the same ore zone where much thinner bodies of ore are found.

**Range of Precipitation.** Chromite may crystallize at different times during a fairly wide range in the period of injection and cooling of the peridotite magma. Thin sections of chromite-bearing ore show corroded chromite grains in dunite and inclusions of olivine in chromite grains, illustrating that chromite may crystallize earlier than the surrounding olivine and also that olivine may start crystallizing earlier than the chromite. Examples of late magmatic chromite were found in the Illinois River area (sec. 25, T. 37 S., R. 10 W.). Thin fracture fillings in the peridotite contain disseminated grains of anhedral chromite in a matrix of antigorite with minor talc, calcite, and magnetite. A sample of material from a ½-in. fracture assayed 16.01 pct $Cr_2O_3$. These fracture fillings undoubtedly represent the very last stages of residual magmatic material. The disseminated grains of chromite showed no apparent resolution textures.

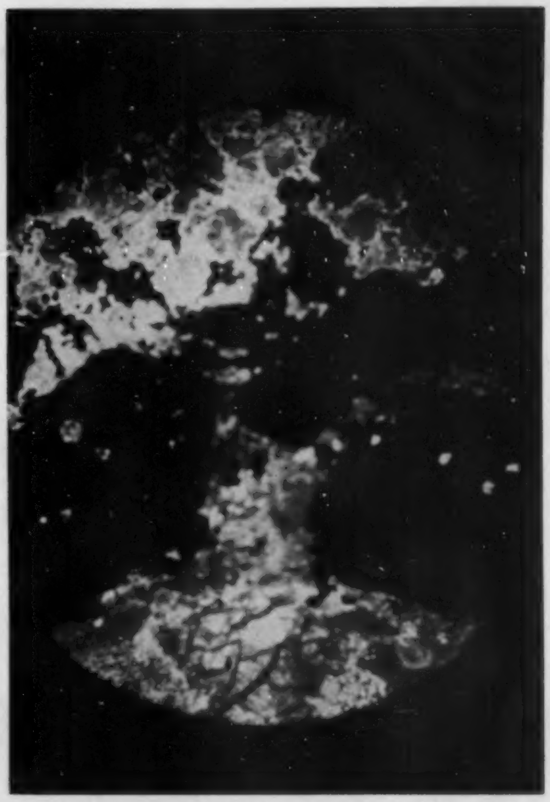
The position of the ore zones in the sill-like intrusions of peridotite or serpentine is also a significant factor in interpreting whether the chromite crystallized early or late. Zones found near the base of a sill formed earlier than zones higher in the intrusion. Ore zones in southwestern Oregon have been found near the base of a sill, near the top, and at intermediate positions. The zones nearly always trend approximately parallel to the nearest contact.

**Nature of Precipitation:** Considerable research has been done by various workers in an attempt to determine the factors giving rise to the precipitation of chromite. The fact that crystallizaion of chromite apparently took place simultaneously over a fairly large area is believed significant. Zones containing chromite at various points along a definite horizon in ultramafic intrusions have been traced for as much as 20 miles in southwestern Oregon. More or less continuous layers of chromite have been traced for greater distances in Montana and the Union of South Africa. It is believed that a widespread chemical and physical balance existed in the peridotite magma that enabled this to happen. Minor amounts of chromite are scattered through the mass of peridotite, but segregation of the chromite to form workable deposits apparently occurred only at a time when ideal conditions for crystallization of chromite existed in the magma. Very little can be determined about the physical conditions (temperature and pressure) that existed at the time chromite was crystallizing most rapidly, but some interesting chemical data have been gathered.

Role of Alumina: Chemical analyses indicate that alumina, which is always present in chromites (from 8 to 33 pct in southwestern Oregon), is at times nearly lacking in the peridotite country rock (from a trace to nearly 3 pct). Either or both alumina and chromic oxide may be the critical oxides giving rise to the discontinuous crystallization of chromite as seen in layered deposits. Peridotite from Nickel Mountain,[2] for example, contains 0.76 pct $Cr_2O_3$ and 0.04 pct $Al_2O_3$. This is a ratio of 19 to 1. The average ratio of chromic oxide to



Micrograph showing corroded chromite grains in thin section of dunite from Nickel Mountain, Douglas County (X10, longest grain is 2 mm).



Micrograph showing inclusions of olivine in chromite crystals in serepentine from Last Drink prospect, Waldo district, Josephine County. Note later-formed small chromite crystals. (X10 large grains about 3 mm diam).

alumina in 18 analyses of southwestern Oregon chromite is 3.7 to 1. It varies from 1.1 to 1 up to a maximum of 7.5 to 1. Other serpentines and peridotites that have a slightly higher alumina than chromic oxide content are located either near chromite deposits or near contacts with rocks of relatively higher alumina content. Work by Thayer[3] in the John Day area; Bateman[4] in the Bird River district, Manitoba; and Smith[5] at the Bay of Islands, Western Newfoundland, placed significance in the position of chromite layers near the overlying gabbros, feldspathic rocks, or other alumina-rich rocks.

A look at the geochemistry of chromium gives added significance to the role of alumina in the crystillization of chromite. According to Goldschmidt[6] metallic constituents with smaller ionic radii form a tighter bond than the larger ions and are concentrated in the early crystals of an isomorphous series. The trivalent cations of chromite ($Al'''$, $Cr'''$, and $Fe'''$) have similar ionic radii and consequently may replace each other readily. Since the ionic radii of $Al'''$ (0.57 A) and $Cr'''$ (0.64 A) are smaller than that of $Fe'''$ (0.67 A) they tend to be more abundant in the early-formed chromite, while $Fe'''$ usually is concentrated in the later-formed chromites.

The same is true of the divalent cations MgO and FeO. Since $Mg''$ has an ionic radius of 0.78 Å and $Fe''$ a radius of 0.83 Å, the early-formed chromites contain relatively higher concentrations of MgO.

Work by Van der Walt[7] stresses principally the reciprocal influence of the formation of chromite and orthopyroxene in the Bushveld complex in Union of South Africa, where the chromite has formed in layers in pyroxenite. Van der Walt was able to prove by chemical analysis that the chromite and pyroxenes crystallized simultaneously from the same melt. He was able to prove that one influx of magma may be responsible for a series of chromite bands. His proof lay principally in the reciprocal relationship of MgO and FeO content in the chromites and silicate minerals.

Chemical analyses made thus far on ultramafic rocks in southwestern Oregon are insufficient to determine conclusively the significance in variation of alumina content and its relation to the chromite deposits. However, the position of ore zones near inclusions or contacts of rocks containing appreciably more alumina than the peridotite and the apparent enrichment of the peridotite in alumina adjacent to these rocks indicate that alumina influenced the crystallization of chromite in southwestern Oregon.

## References


[1] H. Ferid Kromer: Chrome Ore Mining in Turkey. *Engineering and Mining Journal*, April 1954, vol. 155, no. 4.

[2] F. W. Clark: Some Nickel Ores from Oregon. *American Journal of Science*, 1888, 3rd series, vol. 35.

[3] T. P. Thayer: Preliminary Chemical Correlation of Chromite with the Containing Rocks. *Economic Geology*, 1946, vol. 41, no. 3.

[4] J. D. Bateman: Bird River Chromite Deposits, Manitoba. *Trans.*, Canadian Institute of Mining and Metallurgy, 1943, vol. 46.

[5] C. H. Smith: Origin of the Chromite Deposits of the Bay of Islands Igneous Complex, Western Newfoundland. *Economic Geology*, 1953, vol. 48, no. 5.

[6] V. M. Goldschmidt: The Principles of Distribution of Chemical Elements in Minerals and Rocks. *Journal of the Chemical Society*, 1937, pp. 655-673.

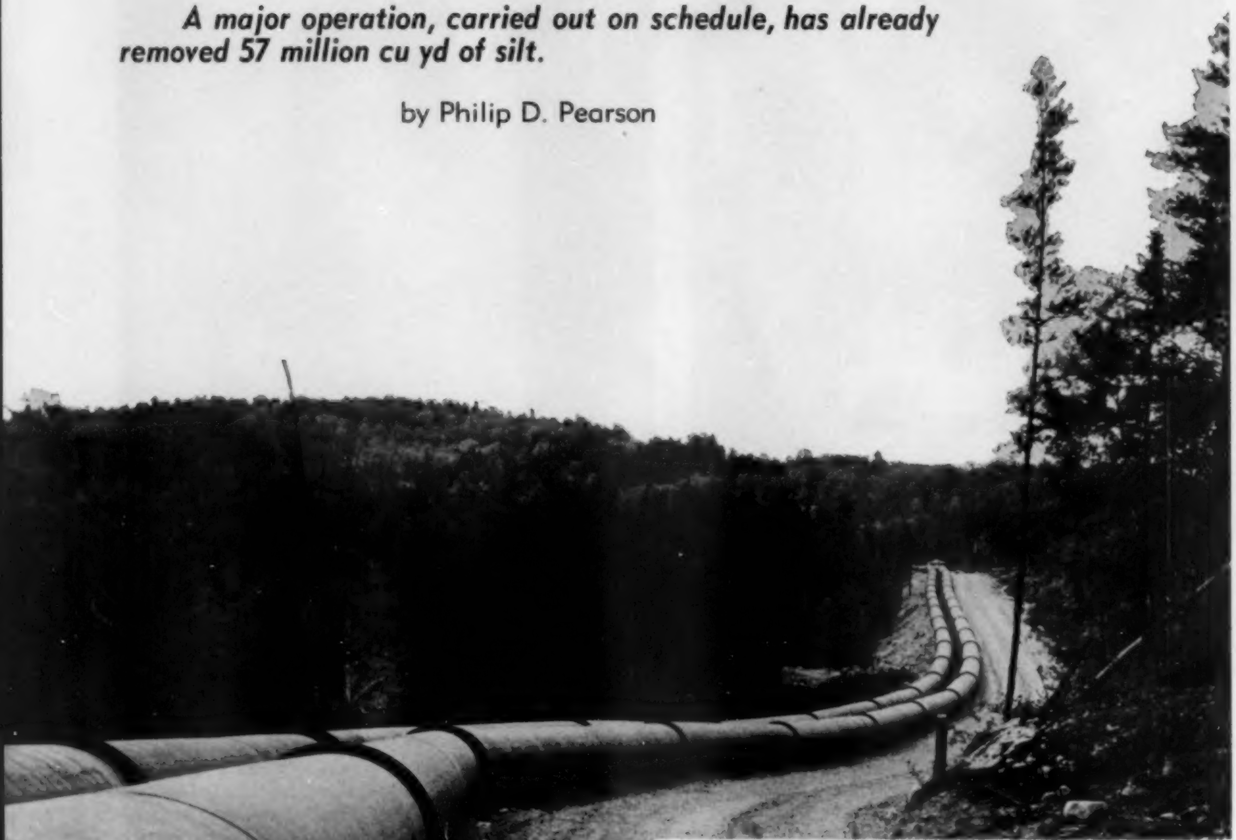
[7] C. F. J. Vanderwalt: Chrome Ores of the Western Bushveld Complex. *Trans.*, Geological Society of South Africa, 1941, vol. 44, Chem. Ser. 167.

[8] L. Ramp: Structural Data from the Chrome Ridge Area, Josephine County, Oregon. Oregon Department of Geology and Mining, *Ind. Ore Bin.*, March 1956, vol. 18, no. 3.

# Dredging at Steep Rock Lake

***A major operation, carried out on schedule, has already removed 57 million cu yd of silt.***

by Philip D. Pearson



CALAND Ore Co.'s dredging program has reached the halfway mark. The goal is to remove more than 160 million cu yd of lake bottom material overlying the iron orebody in Falls Bay of Steep Rock Lake, Ont. Two large dredges were constructed to remove this overburden, a layer of soil about 90 pct varved clay some 400 ft thick. Moisture content of the clay is high—approximately at the liquid limit of the soil.

A few years ago, searching for additional reserves of ore, Inland Steel Co. looked toward Canada and the newly developed Steep Rock iron range. To this end an option agreement was signed Dec. 30, 1949, between Steep Rock Mines Ltd. and Caland Ore Co. Ltd., a wholly owned subsidiary of Inland Steel. Several drilling programs were conducted between this date and Jan. 1, 1953, when a 99-year lease was signed covering an area of 1249 acres. This lease calls for ore production to begin in 1960, with full production of 3 million tons per year by 1969.

**P. D. PEARSON is Manager, Caland Ore Co. Ltd., Atikokan, Ontario, Canada.**

Part of the Falls Bay dredging operation. The dredge RANDALL (top center) is working in Wet Lime Bay, picking up from under the water the material being washed down by the monitor barge (immediately to right of the RANDALL) and pumping it through the 36-in. pontoon line to the No. 1 floating booster. This in turn relays the pumped material to the shore booster (right center). The No. 2 floating booster (center) is pumping water through the shore booster, sending the material on to Marmion Lake. The dredge JOSEPH L. BLOCK is in the foreground, and the shops and warehouses can be seen in front. Immediately to the right of the floating boosters is the Falls Bay transformer station.

Elevation of Steep Rock Lake in the Falls Bay area at the start of Caland's dredging program was 1120 ft above sea level. The top of the ore varies from 600 to 1000 ft above sea level, thickness of silt from 50 to 400 ft, and depth of water to 150 ft.

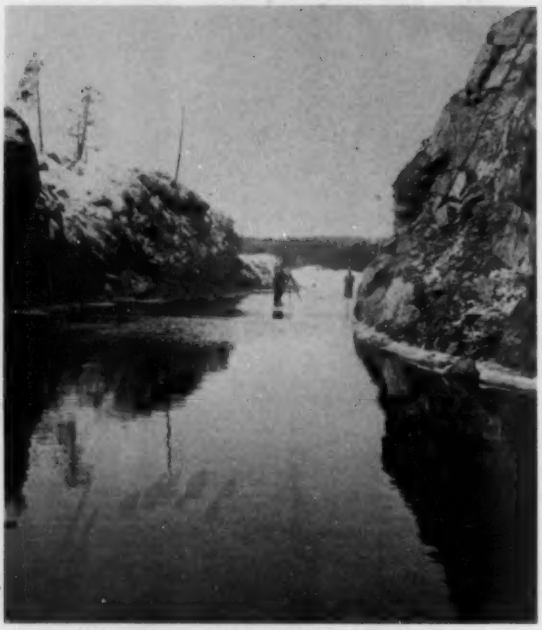
The contract between Caland Ore Co. Ltd. and the dredging firm, Construction Aggregates Corp. (C. A. C.) of Chicago, specified two main phases of the project: 1) the plant phase, for construction of the two dredges and the plant necessary to operate them, and 2) the operating phase, now under way. Target dates for progress and completion of the project are shown in an accompanying table. Since these original dates were set, it has been determined that 182 million cu yd of lake bottom material must be removed. It is expected that under the new schedule dredging will continue until late in 1960. Through Feb. 1, 1957, more than 57 million cu yd have been removed.

Before the dredges could be placed in operation it was necessary to construct several water diversions and controls to form a storage basin for the dredged material and to control the water flowing into Falls Bay. At the north end of Marmion Lake three earth dams were built to prevent lake water from flowing into the Seine River. Simultaneously, a water control works to allow for recharge water was constructed between Marmion Lake and North Twin Lake, and a rock channel was blasted between North Twin Lake and South Twin Lake. Washing down of the shores of Falls Bay was done by the use of monitors while the control works were under way.

## Plant Phase

To handle the large amount of freight required in construction of the dredges, a railroad siding was built at the Hogarth siding of Steep Rock Iron Mines Ltd. seven miles from Falls Bay, and a stiff-legged derrick capable of lifting a 75-ton load was erected at the side of the track. All the material to construct the dredges was then hauled over a gravel road 18 ft wide.

On July 15, 1954, at Falls Bay, Port Authur Shipbuilding Co. completed and launched the hull of a 176 x 50 x 14-ft dredge. The hull of the second unit, identical to the first, was launched Sept. 1, 1954.



Rock cut between North and South Twin Lakes.

Pumps on the two dredges, the two floating boosters, and the two shore boosters are electrically powered by 10,000-hp motors.

By May 1, 1955, the dams at the north end of Marmion Lake had been constructed and the Twin Lakes recharge control was in operation. The Falls Bay transformer station was completed and the 115-kv power line was installed. The two dredges were ready to remove the first yard of silt.

## Operating Phase

In March 1955 the project entered the operating phase of the contract. Working continuously—following the shakedown period—the dredges moved 57,167,150 cu yd of silt from Falls Bay into Marmion Lake. Approximately 66 billion gal (U. S. measure) of water are required to carry this amount of silt.

The two dredges pump the material from the lake bottom to floating boosters, which in turn pump it to a shore booster. This sends the material through the pipelines to the settling basins in Marmion Lake. From here the recharge water passes back through North and South Twin lakes, completing the closed circuit operation.

**Steps in the Dredging Cycle:** 1) Before the pump is started it must be primed. A special priming pump brings water into the suction end of the dredge pump until it covers the intake pipe. When the proper vacuum has been obtained, the dredge pump can be started.

2) The dredge pump is gradually brought up to full speed of 350 to 355 rpm. During this time the vacuum pressure increases from 0 to 15 in. of mercury and the discharge pressure from 0 to 130 or 135 lb.

3) At the same time the inlet water pressure to the floating booster increases. When it reaches 90 lb, the floating booster is started and is brought in stages up to 350 to 355 rpm. The inlet pressure at this time is about 50 lb and the discharge pressure about 200 lb.

4) The next stage is to put the shore booster on the line. The shore booster is brought up to full speed of 350 to 355 rpm and works under an inlet pressure of 70 to 120 lb and a discharge pressure of 220 to 270 lb.

In this system the dredge pump is the No. 1 control and the floating booster the No.2 control; that is, if the shore booster is put on the line before the floating booster is up to speed, it will reduce the discharge pressure from the floating booster, cause cavitation, or perhaps pump the floating booster dry. If the floating booster is put on the line too soon, cavitation occurs and the pump will not perform properly.

To minimize these dangers, electrical controls have been placed on both the floating and shore boosters so that if for any reason the pressure is raised or lowered suddenly, the speeds of the motors are automatically reduced. When the dredge pump is at normal pressure its speed will become normal, and the speeds of the floating and shore boosters in turn will be automatically adjusted to normal.

When all units are on the line and pumping, the dredge cutter on the end of the 74-ft ladder is lowered into the lake bed by block and cable. The cutter is driven by a 1000-hp motor just outside the dredge deck house. Under normal operating conditions this 600-rpm motor turns at about 554.4 rpm and through a reduction gear of 30.8 to 1 gives a normal cutter speed of 18 rpm.

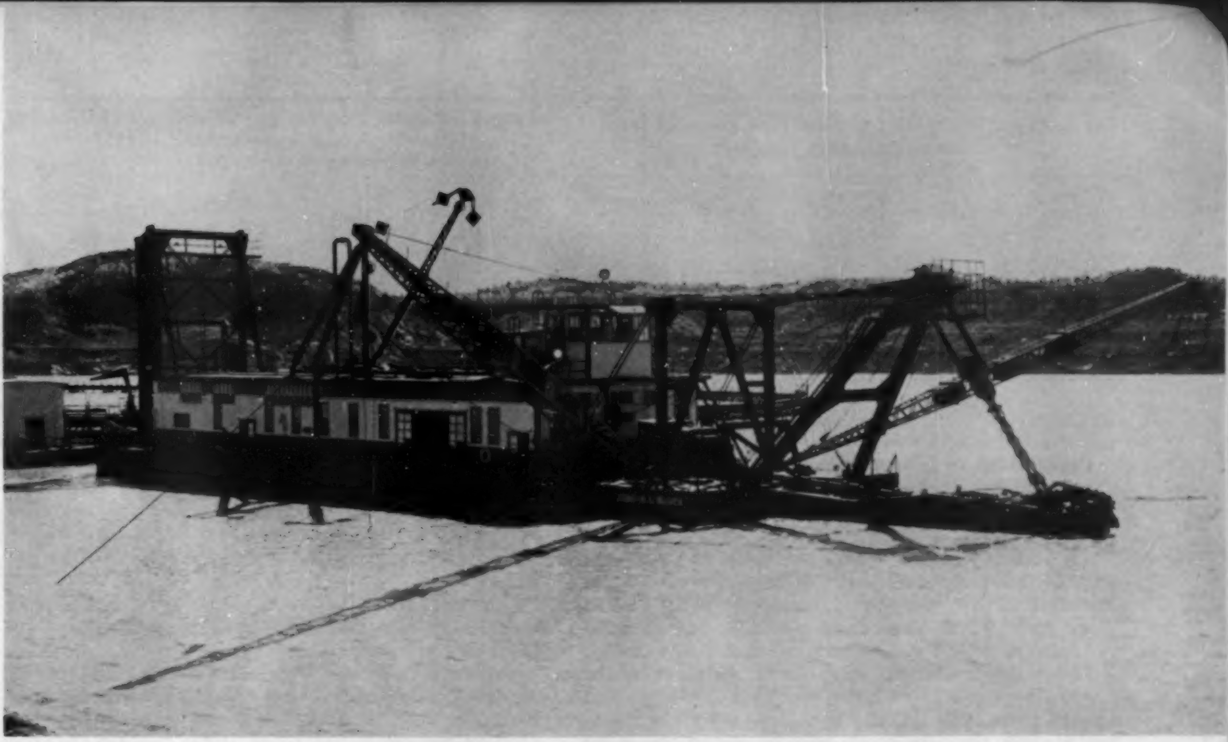
The cutter churns up the lake bottom material directly in front of the open end of the 36-in. suction pipe. This material is picked up by the pump suction and passes through the suction pipe, which is installed in the lower portion of the dredge ladder leading from behind the cutter to an extremely heavy flexible rubber coupling above water level at the entrance of the pipeline to the dredge hull.

From here the material goes through a 36-in. pipe, through which the pump can drive boulders up to 21-in. diam, and under pressure is pumped to the back end of the dredge, where it goes through a swivel coupling joining the rigid pipe mounted on the dredge to the 36-in. floating pontoon pipeline. Thus the material makes its way through the other two pumps to its final settling basin in Marmion Lake.

As a safety measure in the event of silt slides that might bury the cutter and suction pipe, causing damage to the pump, there is a vacuum valve located in the suction line some 45 ft back of the cutter. Under extreme vacuum such as caused by a slide, the valve opens, permitting water to pass through the pump. This is a protection not only against damage to the pump but also against solids building up in the line.

On the intake side of each pump there is a rock-box installed in the pipeline. If a large boulder were to lodge in the pump, a man could enter through the hatch cover on the rock-box and remove the obstacle. It is also possible to enter through this box to inspect the pump and its impeller. An impeller or runner is 96-in. diam and 22 in. from front shroud to back shroud and has four vanes. It is direct-driven by the 10,000-hp motor at 350 to 355 rpm.

Under good operating conditions, when the dredge is digging in silt without too much gravel, the 42-in. shore pipeline is kept full, the flow is approximately 21 fps, and the solids range up to 21 pct, giv-



ABOVE: The dredge JOSEPH L. BLACK in its completed stage. Hull of the dredge measures 176 x 50 x 14 ft, and the pumps are electrically powered by motors with a rating of 10,000 hp. RIGHT: Monitor barge EAST CHICAGO washing silt into Falls Bay.

ABOVE: The two 6 ft diam pipes in the North Twin Lake recharge water control works. LEFT: Facilities for excavating and moving material from Falls Bay into Marmion Lake.

**Sizes and Quantities of Steel Pipe Required for Dredge Discharge Pipelines**

| Sizes, In. | Description | Wt Per Ft, Lb | Number of Pieces | Length, Ft |
|---|---|---|---|---|
| 36 I. D. x ½ | Flanged ends | 194 | 220 | 11,000 |
| 40 I. D. x ½ | Flanged ends | 214 | 20 | 1,000 |
| | Plain ends | | 60 | 3,000 |
| 42 O. D. x ⅜ | Plain ends (lined) | 240 | 640 | 32.000 |
| | Plain ends | 166 | 200 | 10,000 |
| 42 O. D. x ⅝ | Flanged ends | 276 | 10 | 500 |
| | Plain ends | | 70 | 3,500 |
| | Totals | | 1,220 | 61,000 |

**Target Dates for Progress and Completion of Dredging Project. Period Starting May 1, 1955**
(As originally set up in deeding contract)

| Period | Millions of Cubic Yards To Be Removed During Period | Millions of Cubic Yards To Be Removed by End of Period |
|---|---|---|
| 12 months ending April 30, 1956 | 19.5 | 19.5 |
| 12 months ending April 30, 1957 | 38.1 | 57.6 |
| 12 months ending April 30, 1958 | 39.6 | 97.2 |
| 12 months ending April 30, 1959 | 39.0 | 136.2 |
| 6½ months ending Nov. 15, 1959 | 23.8 | 160.0 |

ing a production of 5450 cu yd per hr through a pipeline 22,325 ft long.

**Precautions in Shutting Down:** When the pumps are shut down speed is reduced gradually, lessening the water velocity so that the flap valve in the pipe begins to flutter between the open and closed positions. When the water velocity has been decreased so that the flap valve is almost closed, the pump is knocked off the line and the valve is permitted to close fully. This procedure closes it gently, with no damage to the valve itself or to the line ahead.

When the shutdown is at hand all three units, alerted by radio, slow down to about 250 rpm. The dredge starts the slowdown, followed by the floating booster, then the shore booster. When the shore booster is running at 250 rpm, an indicator on the switchboard shows the operator that the flap valve is fluttering. When the indicator shows that the flap valve is almost in the closed position, the operator knocks the pump off the line and notifies the floating booster. This action closes the flap valve above the shore booster and holds water in the line above it.

The floating booster operator in turn knocks the pump off as soon as the flap valve starts to flutter, 1 to 3 min after the shore booster has shut down. The dredge is then notified by the floating booster that it is off the line and accordingly shuts off its motors.

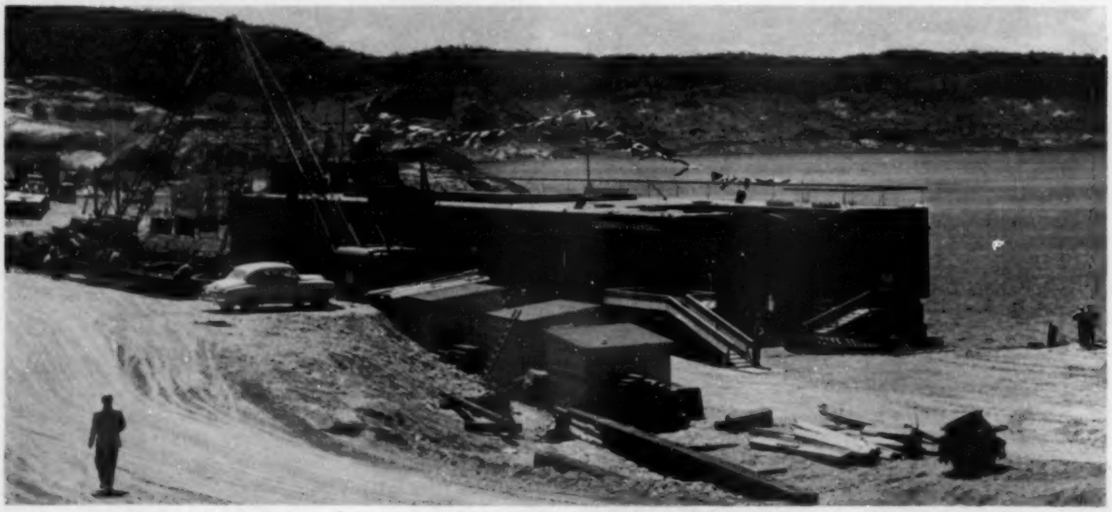
Thus when all three units are down, the line is full of water but held by the flap valves located on the discharge side of the shore booster, the discharge side of the floating booster, and the discharge side of the dredge. If it is necessary to drain the pipeline, the 6-in. valves are opened. These valves are located immediately in front of all three flap valves. Should more rapid draining be required between the floating booster and the shore booster, the pop-off valve at the floating booster can be released.

Communication between the floating equipment, shore, and pipeline personnel is maintained by radio and telephone.

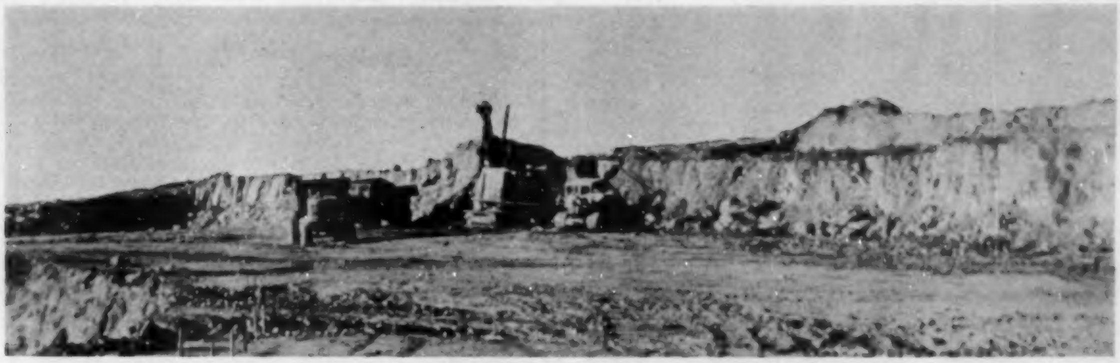
**Status of Program:** Time-wise the Caland Ore Co. dredging program is 50 pct completed; this includes the year and a half required to construct the dredges and set up the plant. It can be said that the plant phase of the project was carried out with dispatch and that the program was started well on time. There is no question that the equipment that has been constructed and placed together is adequate to accomplish this major dredging project and to accomplish it within the period scheduled to commence mining operations.

Production-wise the dredging is slightly ahead of schedule, having removed the required 57 million cu yd of silt by Feb. 1, 1957, lowering the elevation of Falls Bay to 965 ft.

The whole plan of Caland Ore Co. for mining Steep Rock ore is keyed to this dredging program, and as the lake is lowered, the times at which the various elevations of the lake bottom are reached will become the key times for the start of open pit and underground operations.



Hull of the dredge CLARENCE B. RANDALL being prepared for launching.



# Open Pit on Nickel Mountain

***From a fractured orebody requiring little blasting, Riddle nickel is carried 8000 ft to a smelter below.***

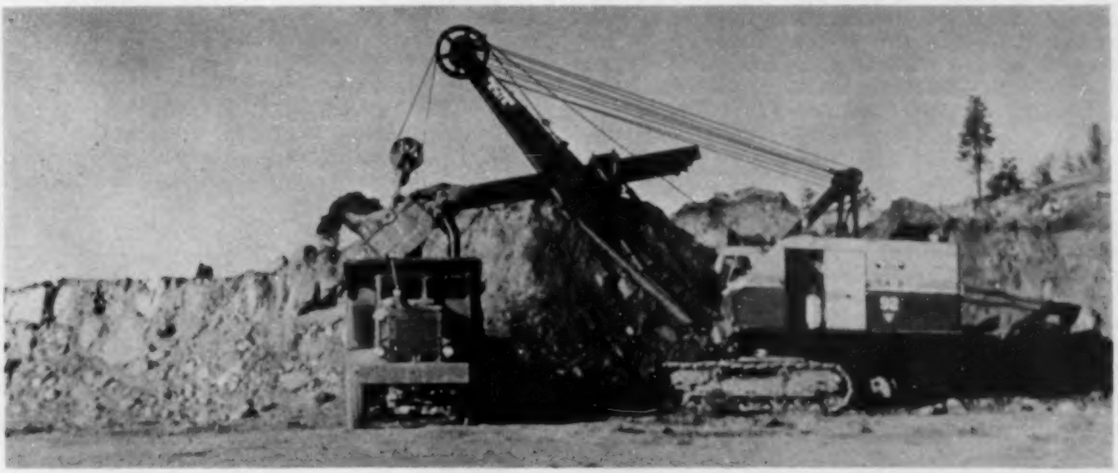
by W. A. Foster

NINETY years after the Riddle nickel deposit was discovered in Oregon in 1864, Hanna Coal & Ore Corp. began mining operations. Until 1954 much prospecting and preliminary development work had been done on the property, but no ore had been shipped other than for metallurgical testing.

The deposit is being explored by churn drilling and trenching, and a few test shafts have been put down for the purpose of studying the ore in place, determining volume and moisture factors, and gathering bulk samples for pilot plant and smelter tests. In churn drilling, 6-in. casing is driven down 2 or 3 ft behind the drill bit and bottomed at each 5-ft interval. All the sludge for each cased 5-ft interval is dumped through a splitter and one eighth is saved and analyzed. Drillholes are stopped after going through the ore zone and penetrating fresh peridotite in which the nickel content is less than 0.5 pct.

The following conservative factors have been used in making estimates: 17 cu ft per short ton in place, 21 pct moisture, and 1.5 pct Ni.

**W. A. FOSTER** is a Geologist with Hanna Coal & Ore Corp., Riddle, Ore.



Tramway loading terminal at Nickel Mountain. The ore travels 8306 ft and drops 2000 ft in elevation before being deposited at the smelter stockpile.

## Geology of the Deposit

The ore mineral is largely garnierite. It occurs as a lateritic concentration in an intricate meshwork of iron-stained and nickel-stained chalcedony boxwork in sheared and weathered peridotite. In its fresh state the peridotite contains about 0.2 pct Ni. The major axis of the orebody strikes northeast and exploration so far has shown it to be roughly 6000 ft long and 3000 ft wide. Ranging from a few feet thick to a maximum of 250 ft, the concentration consists of three general layers: a top layer of brick-red soil; an intermediate thick, yellow, limonitic layer with some quartz-garnierite boxwork; and a root layer composed of quartz-garnierite boxwork in nearly fresh bedrock that is a transition between weathered material and fresh peridotite.

The favorable condition of shearing and fracturing of Nickel Mountain peridotite made possible the formation of the quartz boxwork and garnierite. The nickel is believed to have been derived from olivine in the peridotite by decomposition during lateritic weathering, which probably took place in late Tertiary time prior to uplift and canyon cutting. The Nickel Mountain deposit is an erosional remnant that escaped destruction, and under present climatic conditions the original laterite has been altered, resulting in quartz boxwork and nickel-rich garnierite.

Operations at the deposit can be divided into three phases: 1) open pit mining and hauling, 2) crushing and screening, and 3) shipping.

The property is being developed in a series of level benches, 20 ft maximum height and 50 ft minimum width. Each bench is intersected at several points by haulage roads. Ore is dug from the face of a bench by 2½-cu yd diesel shovels, loaded into 22-ton diesel trucks, and hauled to a stockpile area in front of the screening plant. Truck loads average 17 tons, and with one shovel it is possible to handle 2500 tons per shift. Because of the fractured state of the ore in place, almost no blasting is necessary.

In the second phase of the operation the crushed and screened ore is pushed by bulldozer into a hopper, which feeds it to a 54-in. wobbler feeder consisting of 13 rotating elliptical manganese bars spaced at 5-in. openings. Over the length of the feeder the −5-in. portion of the ore passes between the wobblers and into a bin, from which it is deposited by a 42-in. apron feeder onto a 30-in. belt going to a surge pile of 25,000-ton capacity. The +5-in. portion of the ore is carried over the length of the wobbler feeder by its rotating action and passes down a chute into a 30x42 jaw crusher set at 5 in. The crusher product can either be placed on top of the wobbler undersize traveling to the surge pile or on a 24-in. conveyor belt going to a reject pile. The decision to waste or save the crusher product is made by the engineering staff. Ore on the belt from the plant to the surge pile is sampled at regular intervals as part of the grade control procedure.

A continuous aerial tramway transports the ore from the surge pile on the mountain to the smelter stockpile at the foot. In a concrete tunnel under the surge pile, a 48-in. apron feeder deposits the crushed material on a 30-in. belt, and the ore is weighed and sampled as it travels to a 100-ton storage bin. A 42-in. apron feeder, electrically controlled, places a measured quantity from the bin into the loader, the door of which is tripped by the moving cars. Once in the car, the ore travels 8306 ft and drops 2000 ft in elevation before being deposited at the smelter stockpile. The 50-cu ft cars each carry about 2½ tons of ore down the mountain at 500 fpm. Spaced 260 ft apart by a 2-in. connecting cable, the cars travel loaded on 2-in. track cables and return inverted on 1½-in. track cables. The tramway is held to constant speed by two 300-hp induction generators. When the cars are fully loaded, these generators supply 500 hp in the form of 375 kw being returned to the power source. Two 30-hp electric motors are utilized in starting the tramway to overcome inertia and friction in the system when the cars are empty. Hydraulically controlled brake bands acting on the drive wheel effectively bring the tramway to a stop at all times.

A major problem is to control the grade of ore going to the smelter at 1.5 pct Ni. Since the formation shows no continuity the exploration drillholes can be used only for depth, but daily grade control is now being attempted by visual classification of the banks and by horizontal bank sampling of shovel cuts, which are limited to 10 ft wide. With these methods there must be many cuts available for mining because of the wide variation in nickel grade over the property and because of the time required to dry, prepare, and analyze the bank samples. An average daily shipment must be made up from several areas.

More than a million tons of ore have been delivered to the smelter since operations were started.



Denver To Be Site of Fourth Annual Rocky ... Mineral Industry

# News of . . . Society Institute Profession

## Ouellet to Address AIME-ASME-CIM Fuels Conference Luncheon

Cyrias Ouellet, guest speaker at the October 10th luncheon of the AIME-ASME Joint Solid Fuels Conference, to be held in Quebec City on October 10 and 11, is dean of the faculty of science and professor of physical chemistry at Laval University. Dr. Ouellet received his B.A. at the University and later a B.Sc. degree. He was awarded the doctorate degree from the University of Zurich, Switzerland, and has also done research work at Cambridge University and the University of California. Author of several published scientific papers, he is a member of the Royal Society of Canada and the Canadian Institute of Chemistry. (See program, p. 908.)

The 20th Annual Joint Solid Fuels Conference, which will be headquartered in the Hotel Frontenac, is a jointly sponsored event arranged by the Coal Division of CIM, the Coal Division of AIME, and the Fuels Division of ASME.

The technical program extending through Friday afternoon will provide papers on many facets of coal and other solid fuels production.

*(Continued on page 907)*

CYRIAS OUELLET

## Society of Mining Engineers Choses S. D. Michaelson as President-Elect

STANLEY D. MICHAELSON

Stanley D. Michaelson has been chosen to serve as President-Elect of the Society of Mining Engineers of AIME for 1957. He will become President of the Society in 1958, and has been nominated to serve as an AIME Director for a three-year term, taking office in February 1958.

A native New Yorker, he attended Lehigh University, receiving a B.S. degree in mining engineering in 1934, later doing graduate work there. Although he had done some prospecting in northern Ontario as a student, he began his formal career as a field engineer in the Mining Dept. of Bethlehem Steel Co. Mr. Michaelson was associated for six years with Allis-Chalmers Mfg. Co., first in the minerals research laboratories in Milwaukee, and later as metallurgical engineer and field engineer.

During World War II Mr. Michaelson served five years in the Army as lieutenant colonel in the Ordnance Department. Resuming his career after the war, he rejoined Allis-Chalmers as an ore process engineer. In 1947 he joined Tennessee Coal & Iron Div. of U. S. Steel Corp. where he became chief engineer raw materials.

In September 1954, Kennecott Copper Corp. announced Mr. Michaelson's assignment as chief engineer of the Western Mining Divs. with headquarters in Salt Lake City, a post he now holds.

An active AIME member, Mr. Michaelson served as Chairman of MBD in 1954, and in the same year was elected a Director of the Institute. Some of his technical articles were published in MINING TECHNOLOGY and dealt with ball and rod mill operations.

Nominations of officers of the Society of Mining Engineers of AIME will appear in the September issue. These officers, if elected, will take office in February 1958.

## Exciting Plans Being Formulated for October Tampa Mining Meeting

Plans for the Southeastern States Mining Conference and first annual meeting of the Society of Mining Engineers to be held Oct. 15 to 18, 1957, in Tampa, Fla., are well underway, with a total of 64 papers envisioned for the two days of technical discussions at the beginning of the conference. In the latest schedule, four sessions are slated to run concurrently during that period.

Papers accepted so far fall into five different categories including: industrial minerals, mining, minerals beneficiation, geology and geophysics, and mineral economics.

The various articles are deemed highly qualified and reflect timely and penetrating documentation of such problems as multiple seam coal stripping, industrial dust collection, justification for percentage depletion, and factors concerning the economics of industrial minerals.

Luncheon speakers during the meeting will be Spessard L. Holland, Senior Senator from Florida,

*(Continued on page 907)*

# Denver To Be Site of Fourth Annual Rocky Mountain Minerals Conference, Oct. 31 to Nov. 1, 1957

Denver has been selected as the location for the fourth annual Rocky Mountain Minerals Conference to be held Oct. 30, 31, and Nov. 1, 1957, at the Cosmopolitan Hotel. This city has been prominent in mining circles not only as the gateway to the vast storehouse of the Rocky Mountain minerals, but also as a center for the manufacture of mining equipment and the site of increasing government activity. The Colorado Section, host to the conference, expects excellent attendance at the three-day event.

### Conference Committee

The conference committee, headed by E. H. Crabtree as general chairman, with R. L. Scott as assistant, includes: L. J. Parkinson, program; C. L. Barker, arrangements; G. M. Wilfley, entertainment; A. Hill, finance; and Mrs. J. Paul Harrison, ladies chairman. This committee has been busily engaged in the preparation of a varied and entertaining program, which will feature among other things a novel field trip to the Coors Brewery in Golden followed by an afternoon's sojourn at the football stadium of Colorado University, where the school's homecoming game will be played between the Buffaloes and Missouri.

### Technical Sessions

Five technical sessions are planned for Wednesday, Thursday, and Friday. Papers are being solicited and selected on the basis of timeliness and authoritativeness. Two panels, one on uranium mining and geology and the other on uranium metallurgy, will evaluate alternative methods available for uranium extraction and advancements which have been made in this field. Both American and foreign engineers will be chosen to participate in these discussions.

Although uranium has assumed outstanding importance in this region, topics dealing with the mining and metallurgy of other metals have been tentatively scheduled, including metallurgy of columbium and tantalum, copper mining in southern Arizona, sampling at Rio de Oro, milling practice on the Mesabi Range, and milling practices of the American Chrome Co. The number of papers to be presented will be limited in order to avoid conflicts.

### Officers to Attend

Grover Holt, President of AIME, and Elmer Jones, President of the Society of Mining Engineers will be in attendance during this conference, as well as various dignitaries and prominent officials of the state and municipal governments.

The Ladies' Auxiliary is at work on the planning of an elaborate social program for the female visitors which will provide teas, luncheons, and fashion shows, as well as a dinner-dance and the field trip-football game on Saturday.

**Panorama of downtown Denver, scene of the fourth annual Rocky Mountain Minerals Conference to be held October 30 through November 1. The Conference Committee, headed by E. H. Crabtree, and the Colorado Section, host for the meeting, are hard at work planning a top-notch program of social events, field trips, and technical sessions on many topics of urgent interest to mineral industry engineers.**

## Mineral Industry Meetings

**Sept. 12-14,** Wyoming Geological Assn., 12th Annual Field Conference, Southwestern Wind River Basin, with headquarters in Lander, Wyo. Field trips in area bounded by Winkleman Dome oil field, Rattlesnake Mts., Bison Basin oil field.

**Oct. 3-5,** Seventh Annual Exploration Drilling Symposium, University of Minnesota, Center for Continuation Study, Minneapolis.

**Nov. 14-15,** Third Annual Symposium on Mining Research, Missouri School of Mines and Metallurgy and USBM, Rolla, Mo.

**June 23-28, 1958,** Third International Coal Preparation Congress, organized by the Centre d'Etudes et Recherches des Carbonnages de France, Brussels and Liege, Belgium.

## EJC and ECPD Schedule Engineers Assembly

An Engineers General Assembly is scheduled to be held Thursday and Friday, Oct. 24 and 25, at the Statler Hotel, New York. It will be the first step toward the coordination of the activities of Engineers Joint Council and Engineers Council for Professional Development. The EJC-ECPD joint program committee has arranged a series of panel discussions on topics of mutual interest. The program will examine the following subjects: military service as a factor in professional development, the community college in technological education, the place of the engineer in industrial management, and new dimensions in postgraduate education for engineers.

Concluding the conference will be an assembly dinner celebrating the 25th anniversary of ECPD.

## Third Generation Of Hoover Family Joins Institute

Herbert Hoover, 3rd, of San Jose, Calif., son of the former Under Secretary of State and grandson of the former President of the United States, has been elected a Junior Member of the Society of Petroleum Engineers of AIME.

His father and grandfather are members of AIME, the former President of the United States being the senior Past-President of the Institute. Allen Hoover of Greenwich, Conn., uncle of Herbert Hoover, 3rd, also is an AIME member.

Herbert Hoover, 3rd, was educated at Stanford University and the University of Arizona and to his B.S. degree added an M.B.A. at the Harvard Business School.

## Solid Fuels

*(Continued from page 905)*

The Thursday morning session will offer a picture of Canadian coal consumption and marketing. In the afternoon and in subsequent sessions, specialized topics dealing with dust control, flow of coal in bins, pelletizing of fine coals, thermal stabilization of anthracite by calcination, and the use of gravity methods for cleaning fine sizes of bituminous coal will be presented by various representatives of Canadian and U. S. organizations. A documentary film in color describing the St. Lawrence Seaway and Power Project, entitled *The Eighth Sea,* will lead off the Friday morning session. For the technical program, see p. 908.

Tentatively scheduled for Thursday afternoon are the executive committee meetings and the Joint Solid Fuels Conference Committee meeting, to be followed by a cocktail hour and banquet.

Entertainment, social and sightseeing, will be lavishly doled out to the ladies upon their arrival in the charming and picturesque capital. Trips to a nearby lake, an old French manor, to St. Anne de Beaupre, and a tour of the city will be complemented by a smorgasbord luncheon, a tea, cocktails, and the joint banquet on Thursday night.

## Tampa Meeting

*(Continued from page 905)*

and Marling Ankeny, Director, U. S. Bureau of Mines. Senator Holland will deliver the welcoming address while Mr. Ankeny has been invited to speak at the minerals luncheon on Wednesday. His talk will deal with mining research.

One of the more spectacular notes on the agenda concerns the ladies' program. Entertainment on the larger scale will be provided by a luncheon and fashion show on Gulf beaches and a water ski show and luncheon in Cypress Gardens, the famed locale of Florida-style pageantry. A luncheon at the Siboney Room of the Columbia Restaurant will take place on Friday, while the feature performance of the men's social program may well turn out to be the deep-sea fishing trip.

Two full days have been reserved for field trips, for which final details have been arranged. Thursday's trip will provide visits to Noralyn Mine at International Minerals & Chemical Corp., the triple superphosphate plant of Davision Chemical Co., and The American Agricultural Chemical Co.'s phosphous plant and electric furinaces. For Friday's program alternative field trips are planned for the Lehigh Portland Cement plant in Bunnell and the Diamond Hill Mine of Florida Rock Products Inc., which will take visitors to Brooksville.

## Stop Press Report . . .

### UET Purchases Site For Engineering Center

United Engineering Trustees Inc., through which AIME, ASCE, ASME, AIEE, ASChE own present Engineering Building on 39th St., has announced purchase of property on First Ave. between 47th and 48th St. in New York for the site of a new United Engineering Center. Details on the location will appear in the September issue of MINING ENGINEERING.

## Joint Solid Fuels Conference Technical Program

**THURSDAY, OCTOBER 10, AM**

A. Ignatieff and C. Gerow, *Co-Chairmen*

**9:30**—Coal, A Source of Canadian Energy: *C. L. O'Brian*, Dominion Coal Board.

**10:00**—The Influence of the St. Lawrence Seaway on Marketing of Coal: *John R. Firth*, M. A. Hanna Co.

**10:30**—Canadian Consumption of Industrial Coals: *Gordon M. Hutt*, Canadian Pacific Railway Co., *and E. Swartzman*, Dept. of Mines and Technical Surveys.

**11:00**—Limitations Imposed on Coal Used in Central Canada: *George P. Cooper*, M. A. Hanna Co.

**11:30**—The Canadian Power Situation with Particular Reference to Thermal Electric Power: *C. E. Baltzer*, Dept. of Mines and Technical Surveys.

**THURSDAY, OCTOBER 10, PM**

G. L. Judy and J. B. Morrow, *Co-Chairmen*

**2:00**—Evolution and Growth of Continuous Coal Mining Systems: *Paul R. Paulick*, Consulting Mining Engineer.

**2:40**—Dust Control for Mechanized Underground Mining Stations: *Donald Wiebe*, Joy Manufacturing Co.

**3:20**—Flow of Coal in Bins: *F. D. Cooper and J. R. Garvey*, Bituminous Coal Research.

**FRIDAY, OCTOBER 11, AM**

J. C. McCabe and J. M. Pilcher, *Co-Chairmen*

**9:15**—The Eighth Sea, color film of the St. Lawrence Seaway and Power Project presented by *E. V. Tidman*, Hewitt Equipment Ltd.

**9:45**—Pelletizing of Fine Coals: *Martial P. Corriveau*, Clinchfield Coal Co., *and Thomas Linton*, Link-Belt Co.

**10:30**—Thermal Stabilization of Anthracite by Calcination: *J. W. Eckerd and R. F. Tenney*, USBM.

**11:00**—Problems in Freezeproofing North Dakota Lignite: *R. C. Ellman and J. W. Belter*, USBM.

**FRIDAY, OCTOBER 11, PM**

E. F. Osborn and T. R. Scollon, *Co-Chairmen*

**2:00**—Use Value of Competitive Fuels: *Valeair C. Smith*, Management Group Cos.

**2:40**—Sound Methods of Solid Fuel Evaluation For Use in Thermal Power Stations: *E. D. Holdup*, Hydro-Electric Power Commission of Ontario.

**3:20**—The Use of Gravity Methods for Cleaning Extreme Fine Sizes of Bituminous Coal: *D. R. Mitchell and H. B. Charmbury*, Pennsylvania State University.

## Ladies' Program

**THURSDAY, OCTOBER 10, AM**

**9:00**—Registration
**10:00**—Coffee Get-Together

**THURSDAY, OCTOBER 10, PM**

**12:30**—Bus Tour to Lac Beauport
**1:00**—Lunch at Manoir St. Costin
**2:30**—Bus Tour of Quebec City
**6:00**—Cocktail Hour
**7:00**—Banquet

**FRIDAY, OCTOBER 11, AM**

**9:30**—Bus Tour to St. Anne de Beaupre

**FRIDAY, OCTOBER 11, PM**

**1:00**—Smorgasbord
**3:00**—Tea at Citadelle


# ROCK IN THE BOX

## *News of M.G.G. Division*

A highly important year-round committee operation within the division is performed by the Divisional Publications Committees, and particularly by the chairmen who must tie together the work of the various committeemen, as well as that of the various readers. To underline the regard in which the work of these people is held, we can do no better than quote from *Drift*, March 1954:

"The Divisional Publications Committees perform one of the most important functions of the Institute. They have the very high purpose of examining the papers submitted to AIME and approving them for publication.

"The Committees act as readers or select readers who are experts in the field covered by the paper. These members are not editors, but are the critics of the scientific information included in the paper. When this panel of experts has completed its review, the manuscripts selected should be the latest and most correct original information available on the subject.

"The Institute, and therefore the whole of the membership, is dependent upon the Divisional Publications Committees to see that material published by AIME is of unquestioned technical accuracy, and that high professional standards are maintained, regardless of the position of the author. These expert readers must be alert in protecting the membership from the banal article, the self-advertisement, and from the rehashed review, as well as active in finding and pushing forward the vital, original technical information that the professional mining man must have to help his industry grow stronger. This is the Committee's responsibility."

Brief biographies of the hard-working chairmen, as well as that of H. C. Weed, MGGD representative on the Society of Mining Engineers Transactions Editorial Committee, are given below. Mr. Weed is chairman of the Society Transactions Editorial Committee.

—*Clark L. Wilson*
*Chairman, MGG Division*


H. C. WEED


J. M. EHRHORN


H. R. GAULT


H. M. MOONEY

**MGGD Representative on Society of Mining Engineers Transactions Editorial Committee**—H. C. Weed is a graduate of Michigan College of Mines, and a native of Michigan. His mining experience has included jobs as efficiency engineer and miner for Calumet & Hecla Mining Co. and United Verde Copper Co. in Jerome, Ariz. In 1937 he joined Inspiration Consolidated Copper Co., Inspiration, Ariz., where he was employed as shift boss. At present he holds the position of assistant general manager for the company. Not only is he MGGD representative on the Transactions Editorial Committee, but Mr. Weed was chosen as chairman of the Society Committee and serves as chairman of the Society of Mining Engineers' Editorial Board.

**Mining**—Jack M. Ehrhorn graduated from Stanford University with a degree in mining engineering in 1927. After working as a miner, timberman, and shift boss for United Verde

*(Continued on page 915)*

### Robert Peele Award

One of the features of the various Division activities is presentation of special awards recognizing a particular talent or service to the industry. The Robert Peele Award was established in 1953 by the Mining, Geology, and Geophysics Division of AIME in honor of the distinguished mining engineer, educator, and author for whom it was named. The award is given for the most outstanding paper on a mining, geology, or geophysics subject published in the *Transactions* during the period under review. One or more of the authors must be AIME members not over 40 years of age at the time the paper was submitted to the Institute for publication.

Papers are judged for the award on the following basis:

1) For significance of contribution to the engineering literature of metal mining, geology, or geophysics.

2) For the excellence of technical writing. The papers must be an original contribution of permanent interest and of practical or technical value. AIME publication of the paper is required and more than one author may qualify.

The award consists of a $100 prize and certificate and is presented at the MGGD luncheon during the Annual Meeting.

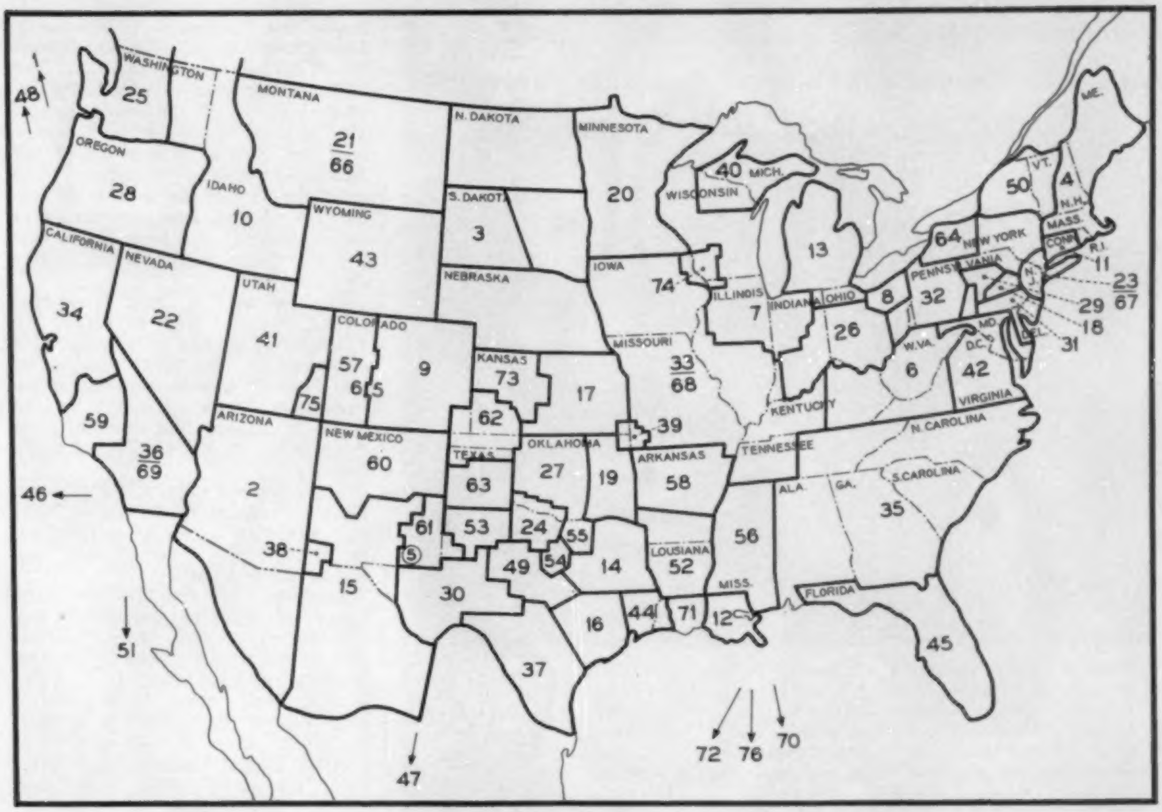
The Peele Award Committee personnel this year includes Jack M. Ehrhorn, H. R. Gault, George R. Rogers, Rollin Farmin, Darwin J. Pope, and Thomas G. Moore. The first two named are Chairmen of the Publications Committees for Mining and Geology, and Jack Ehrhorn is also the Peele Award Committee Chairman.

There has been no endowment established for the Peele Award and there is no other appropriation of funds to cover the cost. Our only recourse is to ask for contributions on a personal basis from friends of Peele or others who are interested in this MGGD activity. We would like a large enough fund at this time to carry the award for two or three years, thereby giving time for consideration of the endowment. Anyone who would care to contribute is asked to send their check to the MGGD Secretary, Glen A. Burt, 815 Kearns Building, Salt Lake City 1, Utah.—*C.L.W.*

# Map, Location, and Identification of AIME Local Sections

***Listings Below Include the Name and Address of the Local Section Secretary, or Secretary-Treasurer; Subsections; Groups; NOHC Local Sections and Their Chairmen***

*1—Alaska*
Bruce I. Thomas, USBM, P.O. Box 154, Fairbanks, Alaska.
*2—Arizona*
R. F. Welch, 810 Valley National Bldg., Tucson, Ariz. **Subsections:** Ajo, Bisbee-Douglas, Morenci, Yavapai.
*3—Black Hills*
Ted M. Rizzi, 740 Railroad, Lead, S. D.
*4—Boston*
Thomas B. King, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge 39, Mass.
*5—Carlsbad Potash*
Adolph V. Mitterer, International Minerals & Chemical Corp., Box 71, Carlsbad, N. M.
*6—Central Appalachian*
Charles T. Holland, P.O. Box 836, Blacksburg, Va.
*7—Chicago*
W. G. Wilson, Molybdenum Corp. of America, 38 S. Dearborn St., Room 1765, Chicago 3, Ill.
*8—Cleveland*
M. E. Ault, 4186 W. 144 St., Cleveland, Ohio.
*9—Colorado*
William L. Miles, Jr., American Smelting & Refining Co., 803 First National Bank Bldg., Denver 2, Colo. **Subsection:** Pikes Peak.
*10—Columbia*
Rollin Farmin, Box 1010, Wallace, Idaho. **Subsections:** Snake River, Spokane, Coeur d'Alene.
*11—Connecticut*
Clyde Wilhelm, International Silver Co., Factory AJ, Wallingford, Conn.
*12—Delta*
E. A. Colle, Jr., Schlumberger Well Surveying Corp., 451 National Bank of Commerce Bldg., New Orleans, La.
*13—Detroit*
R. E. Mahr, Chrysler Corp., Missile Operations, P.O. Box 2628, Detroit 31, Mich. **Group:** Detroit Powder Metallurgy.
*14—East Texas*
J. P. Richards, Tidewater Oil Co., Drawer 152, Kilgore, Texas.
*15—El Paso Metals*
Guy E. Ingersoll, Texas Western College, El Paso, Texas.
*16—Gulf Coast*
M. Scott Kraemer, Stanolind Oil & Gas Co., Houston, Texas.
*17—Kansas*
Howard Haynes, Box 2233, Wichita, Kan.
*18—Lehigh Valley*
A. T. Kaufman, Mining Div., Bethlehem Steel Co., Bethlehem, Pa.
*19—Mid-Continent*
E. H. Timmerman, Shell Oil Co. Inc., Box 1191, Tulsa, Okla.
*20—Minnesota*
Norman A. Moberg, 610 Wolvin Bldg., Duluth 2, Minn. **Subsections:** Mining, Minerals Beneficiation.
*21—Montana*
Clifford J. Hicks, 526 Hennessy Bldg., Butte, Mont.
*22—Nevada*
Victor T. Howard, 131 Constitution Ave., Henderson, Nev. **Subsections:** Reno, Southern Nevada, Eastern Nevada.
*23—New York*
David T. Steele, American Metal Co. Ltd., 61 Broadway, New York 6, N. Y. **Groups:** Physical Metallurgy, Powder Metallurgy.
*24—North Texas*
Kenneth W. Lagrone, Shell Oil Co., Box 2010, Wichita Falls, Texas.
*25—North Pacific*
Kenneth A. Johnson, 4673 41st Ave., N.E., Seattle 5, Wash.
*26—Ohio Valley*
J. R. Lucas, 212 Lord Hall, Ohio State University, Columbus, Ohio.
*27—Oklahoma City*
Burrell G. Taylor, Kerr McGee Oil Industries, Kerr McGee Bldg., Oklahoma City, Okla.
*28—Oregon*
Elmer E. Howard, The Carborundum Co., Box 291, Vancouver, Wash.
*29—Pennsylvania-Anthracite*
Thomas R. Weichel The Okonite Co., Wilkes-Barre, Pa.
*30—Permian Basin*
Harry L. Horton, Dowell Inc., 103 Phillips Bldg., Odessa, Texas.
*31—Philadelphia*
Raymond L. Smith, Laboratories for Research & Development, The Franklin Institute, Philadelphia 3, Pa.
*32—Pittsburgh*
J. M. Vonfeld, Pittsburgh Coal Co., Library, Pa. **Subsection:** Petroleum. **Group:** Institute of Metals.
*33—St. Louis*
Gordon M. Bell, Alcoa Research Laboratories, P.O. Box 497, East St. Louis, Ill.
*34—San Francisco*
L. A. Norman, Jr., 41 Sutter St., Room 709, San Francisco, Calif.
*35—Southeast*
Robert J. Blair, Black Diamond Coal Mining Co., 2229½ First Ave., North Birmingham, Ala. **Subsection:** Eastern North Carolina.
*36—Southern California*
A. T. Cape, 724 South Victory Blvd., Burbank, Calif. **Subsection:** Southern Sierra.
*37—Southwest Texas*
T. C. Storer, Pan American Petroleum Corp., Box 1980, Corpus Christi, Texas. **Subsection:** Austin-San Antonio.
*38—Southwestern New Mexico*
David W. Boise, 917 West St., Silver City, N. M.
*39—Tri-State*
Hugh Wright, Tri-State Zinc & Lead Ore Producers Assn., P.O. Box 36, Picher, Okla.
*40—Upper Peninsula*
Roy W. Drier, Michigan College of Mining and Technology, Houghton, Mich. **Subsections:** Minerals Beneficiation, Exploration, Mining.
*41—Utah Section*
Charles C. Hilton, U. S. Smelting, Refining and Mining Co., P.O. Box 1980, Salt Lake City 10, Utah.
*42—Washington, D. C.*
Jesse A. Miller, Branch of Light Metals, Div. of Minerals, Dept. of the Interior, Washington, D. C.
*43—Wyoming*
J. Spence Winn, Trigood Oil Co., P.O. Box 1571, Casper, Wyo.
*44—Spindletop*
J. A. Buvens, Dowell Inc., Box 2353, Beaumont, Texas.
*45—Florida*
Herbert R. Quina, P.O. Box 175, Pierce, Fla.
*46—Philippine*
J. W. Pickard, Koppel Philippines, P.O. Box 125, Manila, P. I.
*47—Mexico*
John T. Carty, Dolores 17-901, Mexico City 1, D. F., Mexico.
*48—Southwestern Alaska*
George R. Schmidt, 2101 Sunrise Dr., Anchorage, Alaska.




49—*West Central Texas*
Philip M. Bridges, Russell Engineering, 101 Petroleum Bldg., Abilene, Texas.

50—*Adirondack*
Charles Dievendorf, International Talc Co., Gouverneur, N. Y.

51—*Lima, Peru*
Walter E. King, Av. Santa Cruz 331, Miraflores, Lima, Peru.

52—*Lou-Ark*
Don R. Boling, National Tank Co., P.O. Box 1228, Shreveport, La.

53—*South Plains*
Barney Vachal, Box 472, Brownsfield, Texas.

54—*Fort Worth*
K. L. Dominy, Midwest Oil Corp., Sinclair Bldg., Fort Worth, Texas.

55—*Dallas*
Fred L. Oliver, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Texas

56—*Mississippi*
Byron O. Sims, Jr., Magnolia Petroleum Co., P.O. Box 479, Natchez, Miss.

57—*Colorado Plateau*
T. S. Ary, 1340 Houston Ave., Grand Junction, Colo.

58—*Arkansas*
Jack C. McFarlin, Reynolds Mining Corp., P.O. Box 398, Bauxite, Ark.

59—*San Joaquin Valley*
N. B. Clark, Jr., Union Oil Co., P.O. Box 613, Bakersfield, Calif.

60—*Central New Mexico*
E. P. Chapman, Jr., P.O. Box 8302, Albuquerque, N. M.

61—*Hobbs*
Robert M. Williams, Shell Oil Co., Box 1957, Hobbs, N. M.

62—*Hugoton*
G. W. Godfrey, Panhandle Eastern Pipe Line Co., Box 979, Liberal, Kan.

63—*Panhandle*
J. D. Kenworthy, Kewanee Oil Co., Pampa, Texas.

64—*Niagara Frontier*
C. H. Emery, Simonds Saw and Steel Co., Lockport, N. Y.

65—*Denver Petroleum*
John A. Banister, Jr., Halliburton Oil Well Cementing Co., 1212 University Bldg., Denver, Colo. **Subsection:** Uintah Basin.

66—*Billings Petroleum*
George G. Brown, Mobil Producing Co., P.O. Box 2548, Billings, Mont.

67—*New York Petroleum*
Gordon F. Ahalt, Chase-Manhattan Bank, 18 Pine St., New York 15, N.Y.

68—*Illinois Basin Petroleum*
Bill G. Harmon, B. G. Harmon Service & Equipment, Box 309, Carmi, Ill.

69—*Southern California Petroleum*
W. F. Cerini, Union Oil Co. of California, 9645 S. Santa Fe Springs Rd., Whittier, Calif.

70—*Eastern Venezuela Petroleum*
G. J. Clarke, Mene Grande Oil Co., Apartado 3974, Caracas, Venezuela.

71—*Evangeline*
John C. Willis, Forest Oil Corp., Box 1401 O.C.S., Lafayette, La.

72—*Western Venezuela Petroleum*
Loren F. Kahle, Jr., Creole Petroleum Corp., Lagunillas, Zulia, Venezuela.

73—*Great Bend*
Lawrence T. Appelbaum, The Carter Oil Co., Box 786, Great Bend, Kan.

74—*Upper Mississippi Valley*
Harold A. Wisco, 200 East Mary St., Darlington, Wis.

75—*Uranium*
Lauren L. Ball, Minerals Exploration & Development, P.O. Box 487, Moab, Utah.

76—*Caracas Petroleum*

## NOHC Local Sections

*Buffalo*—J. R. Atkinson, chairman, Hamilton, Ont., Canada.

*Chicago*—H. Erler, chairman, Gary.

*Cleveland*—C. W. Cravens, chairman, Cleveland.

*Detroit*—M. Groat, chairman, Ecurse, Mich.

*Eastern*—C. D. Moore, chairman, Plymouth Meeting, Pa.

*Northern Ohio* — Joseph Turner, chairman, Youngstown.

*Pittsburgh*—D. L. McBride, chairman, Pittsburgh.

*Southern Ohio*—Paul Sammet, chairman, Ashland, Ky.

*Southwestern* — K. P. Campbell, chairman, Houston.

*Western*—Carl Wissman, chairman, Bakersfield, Calif.

## Norwood Society Students Review Year; Old Timers Award to Harold Franklin at Kentucky University

Harold K. Franklin, Sturgis, Ky., was the 1957 recipient of an Old Timers award at the University of Kentucky. Among those witnessing the presentation of the award by Samuel M. Cassidy, Kentucky alumnus and vice president, Pittsburgh Consolidation Coal Co., were, left to right: Fred Salisbury, Juel H. Stears, Robert H. Jones, Harold Franklin (award winner), Mr. Cassidy, Charles H. Reed, and James T. Tyson. Those present are junior and senior mining engineering students at the University.

The Norwood Society, AIME Student Chapter at the University of Kentucky, Lexington, has chalked up a busy semester and is anticipating an even more successful year in the fall with increased enrollment in mining and metallurgical engineering courses.

Numerous speakers were on hand to boost attendance at the Chapter's meetings during the year. In April the members were invited to tour the Naval Ordnance Plant in Louisville. A visit to the Coal Show in Cleveland by some of the mining students took place in May. The annual spring picnic capped off the season's activities with fun for all who partook.

The Society recently held its elections for the coming year. The following have been chosen to serve as officers next fall: Richard J. McMannon, president; Richard D. Hunsinger, vice president; Carter G. Brown, secretary; Leslie B. Claxton, treasurer; Gerald R. Scott, sergeant at arms; Hugh V. Shotwell, engineering student council; Prof. C. S. Crouse, faculty adviser; and Hal W. Maynor, Jr., sponsor.

An award conferred each year by the Old Timers Club upon the outstanding senior in mining engineering at the University of Kentucky, Lexington, was presented to Harold K. Franklin of Sturgis, Ky. The Old Timers was founded several years ago by 30 nationally prominent mining engineers who organized the club at a meeting of the American Mining Congress. The chief purpose of the awards to students in the coal area is to recognize top scholarship and to welcome into the coal industry its future leaders and pioneers.

The award, a gold engraved pocket watch, was presented to Franklin by Samuel M. Cassidy, vice president of Pittsburgh Consolidation Coal Co. and an alumnus of the University, at a ceremony in the Dept. of Mining and Metallurgical Engineering of the College of Engineering.

A graduate of Sturgis High School, Harold Franklin is the son of Herman Franklin, a coal mine foreman. He worked for a period with the Poplar Ridge Coal Co.

Selection of Franklin for the honor was made by members of the engineering faculty. Other recipients of the award at the University of Kentucky have been: H. L. Kirkpatrick, 1949; Harry L. Washburn, 1950; Billy F. Eads, 1951; B. F. Allison, 1952; James R. Steward, 1953; Charles Daniel Gibson, 1954; Billy Tom Henshaw, 1955; and Don Richard Batten, 1956.

## Personnel

*(Continued from page 824)*

able; preferably single status. Salary, $3600 to $4200 a year. Location, South America. F5072.

**Assistant Professor,** Ph.D. degree, with special interest in the fields of mineralogy and petrology. In addition, may be required to teach some minor items, such as possibly a section of physical geology and a section of field geology. Salary, open. Starts Sept. 1, 1957. Location, West. W4925.

## Southwestern Alaska Section Holds Two Successful Meetings

Two annual functions sponsored by the Southwestern Alaska Section took place on Saturday, March 30, and were very well received.

### Section Conference

The Second Annual Mining and Minerals Conference, held during the morning and afternoon, provided a series of excellent talks, followed by a question and answer period by various members of the mining and geological professions in the Territory.

Phil Holdsworth, Territorial Commissioner of Mines, delivered the lead-off address on recent territorial mining legislation, which was followed by a description of the Kenai Chrome Co.'s operations at Red Mountain by Karl A. Bachner. John Murphy spoke on mercury mining at the Red Devil Mine, which accounts for approximately one third of the domestic mercury production.

In the afternoon session, Leo Mark Anthony, of the University of Alaska School of Mines, gave a detailed lecture on geochemical prospecting which was followed by a case history on geochemical prospecting in the McGrath Property, presented by Donald Stein, Territorial Assayer. Permafrost and its action on various types of structures was discussed by Russell A. Paige of the USGS. Ervon Fairbanks described platinum recovery at Goodnews Bay, the only platinum operation in the United States, and Earl H. Beistline, dean of the School of Mines, University of Alaska, gave an account of the current federal mining legislation.

### Section Banquet

In the evening, the Section's annual banquet was held in the Elks' Hall, with about 300 in attendance. Phil Holdsworth, the principal speaker, impressed an enthusiastic audience with his timely talk on the outlook for future power developments in the Rainbelt area. In it he dwelled on the concept of building power generators at the site of coal mines rather than shipping the coal to the generators. Other speakers were Dean Beistline and Robert Seraphim of the Moneta Porcupine Mining Co., Vancouver.

### Visitors' Breakfast

On Sunday morning, the out of town visitors were treated to breakfast at the home of Section Chairman William Strandberg, during which cobwebs of the previous evening were washed away with generous drafts of *moose milk*. A precedent was established for future occasions of similar mirth and moment.

# *Around the Sections*

• The **Oregon Section** met on May 17 at Henry Thiele Restaurant, Portland. Featured speaker on that occasion was Ira S. Allison, professor of geology, Oregon State College, Corvallis, Ore. Dr. Allison's subject was *Thailand in Transition*, and he illustrated his talk with colored slides of the industry and daily life of the people which he observed during his recent tour of duty at Kasetsart University in Bangkok.

• Three divisions of the **Arizona Section** held meetings recently. The Smelting Div. met at San Manuel Smelter, San Manuel, on May 18. Lunch was served at the Triple X Cafe after the morning registration. The afternoon session consisted of field trips through the smelter, mill, and powerhouse during which time the visitors had access to the entire operations. The staff and foremen were on hand to answer questions for the group. In the evening a cocktail party and dinner were held on the grounds of the Rancho de los Robles at Oracle, Ariz., with 82 members and guests in attendance.

The Ore Dressing Div.'s spring meeting took place in Bisbee, Ariz., on March 30. At the morning session and luncheon, 95 members and guests were present, while the cocktail party and dinner were attended by 116. During the afternoon, guided tours were conducted through the Lavender Pit and Concentrator. Also present were 23 students from the University of Arizona.

The Open Pit Div. held its spring meeting on April 26 at Morenci. Nearly 150 persons were on hand for the event: 55 local members and guests and 91 from out-of-town. The morning was devoted to a general tour of the Morenci operation, followed by lunch at Longfellow Inn. At the technical session in the afternoon in the Morenci Club, the following three papers were read: *Power Distribution at Morenci Open Pit* by Felix Berra; *Use of an Industrial Engineering Department in the Chino Mine* by G. J. Ballmer; and *Skip Haulage at Pima Mining Co.* by R. E. Thurmond. Discussion groups met later to discuss engineering, drilling and blasting, track maintenance and signaling, repair and maintenance, and supervisory training. The day's events concluded with cocktails and dinner at the Morenci Club. L. M. Barker, Morenci, was master of ceremonies for the evening.

• The **Chicago Section** held its annual President's Night dinner-dance at the Shoreland Hotel on Saturday, May 4. The business meeting the preceding afternoon was attended by AIME President Grover J. Holt and Secretary Ernest Kirkendall, affording the Section an opportunity for first hand reports on AIME activities. An outstanding success, the dinner-dance was attended by 400. Members and guests danced to the strains of Rudy Austin's orchestra in the Louis XVI Room of the Shoreland. Highlight of the evening was the talk by President Holt. He complimented the Section on the splendid meeting, encouraged continued active participation by members, and commended the vigorous program for increasing AIME membership.

• The **Washington, D. C., Section** organized a field trip on June 4th. They visited the Potomac River generating station of the Potomac Electric Power Co. and the Potomac Yards of the Richmond, Fredericksburg, and Potomac Railroad. At the freight yard they saw the use of such modern techniques as automatic car switching, television, and electronic computing equipment.

• A spring field trip was held by the **Lehigh Valley Section** on June 21. Members visited plant No. 4 of Mack Trucks Inc. where they observed the assembly of heavy trucks and buses. They also saw a film, *Bulldog Convoy in the Arctic*.

• The annual dinner-dance of the **St. Louis Section** was held on May 10 at the Missouri Athletic Club. Preceded by a cocktail party, the affair this year honored AIME Vice President Roger V. Pierce. Addressing the Section on *The Minerals Engineer and What's Next*, he stressed the lack of proper scientific education in many high schools as a possible cause for the shortage of engineers, and for the lack of interest in the mineral engineering field by younger students.

On April 12, the Section's spring plant visit was made to Monsanto Chemical Co.'s sulfuric acid plant and to the electrolytic zinc plant of American Zinc Co. at Monsanto, Ill. A dinner-meeting in East St. Louis preceded the trip.

• A **Colorado Section** dinner meeting held jointly with the Student Chapter, Colorado School of Mines, took place on April 18, at the University Club in Golden. Featured speaker was Theodore F. Adams, project manager for Blue River Constructors, who discussed the engineering problems involved in driving a 23-mile water diversion tunnel, and sinking the 1000-ft Montezuma access shaft.

The Section met jointly with the distaff on May 16 at the University Club. The program consisted of a talk by W. R. Ross, president, Colorado State College of Education at Greeley. Dr. Ross spoke on *Some Recent Trends in Science Education*.

• The **Reno Subsection** held its regular luncheon meeting on May 10 at the Mapes Hotel, Reno. The program consisted of the winning papers of the recent AIME Nevada Section student contest. Two papers were read: *A New Mississippian Spiriferoid Brachiopod*, by Louis Lohr; and *Geology of a Portion of the Antelope Range, Nevada*, by Max Botz.

• The **Black Hills Section** meeting on May 16 took place at the Lead Country Club, Lead, S. D. Guest speaker Clarence N. Kravig, mine superintendent, Homestake Mining Co., Lead, addressed the 47 members and guests on *Long Raises in New Homestake Development*. A routine business meeting followed. The Section will meet again in September in the Rapid City, S. D., area.

• The **Ajo Subsection** met at the Ajo Country Club, Ajo, Ark., on April 18. At that time, J. D. Forrester, dean of the College of Mines, University of Arizona, addressed the junior and senior students of the Ajo High School who are interested in becoming engineers.

• In the **Pennsylvania-Anthracite Section,** William W. Kay has been appointed by the Section Chairman to serve as chairman of the membership committee, filling the vacancy created by the resignation of George Drake who has moved out of the Section. Robert Walsh, Mine Safety Appliance Co., has been appointed to serve on the national membership committee of the Institute of Metals Division for a three-year term.

• The **Montana Section** was host at the annual Anaconda meeting on April 13, at the Montana Hotel in Anaconda. This was a joint meeting with the Montana Society of Engineers. A refreshment hour, courtesy of the Anaconda Co., was enjoyed by the large group present, prior to the roast beef dinner. Stanley Lane, Section chairman, presided and introduced the officers of both organizations. A welcoming speech was offered by Mr. Emanuel, manager of the Anaconda plant. The program for the evening was presented by Melvin A. Stokke, superintendent of construction at Anaconda. His paper dealt with the new crushing, conveying, and electronic weighing system recently installed at the Anaconda

plant. Mr. Stokke's well illustrated talk covered ore handling from the time the railroad cars are dumped until the ore reaches the fine ore bins at the concentrators.

***Research—Key to Progress* is a 16-mm sound color film available free from the Public Relations Dept., Armour Research Foundation, 10 W. 35th St., Chicago, Ill. The documentary film which runs 15 min, depicts the role of industrial research in the nation's economy, tracing the phenomenal rise of research and its contributions to the high standard of living in the U. S. It was produced by Armour as a public service.**

**The story of one of the largest earth moving operations is told in a 17-min color film, *Moving a Mountain Into a Lake.* The picture shows giant electric shovels tearing down a 30-million-ton mountain of earth and rock near Salt Lake City to build a 13-mile roadbed across the Great Salt Lake for the Southern Pacific Railroad. The earth and rock are transported two miles by a belt conveyor system designed by Hewitt Robins. In addition to demonstrating the operation, the film gives a detailed explanation of how the company designed, manufactured, and erected the conveyor system. Prints may be obtained from Hewitt-Robins Inc., Stamford, Conn.**

**Two recent films on aluminum are now available for free loan. In *Aluminum on the March,* a 28-min movie in Eastman color, produced by Jam Handy Studios, the camera roves from bauxite mines to rolling mills, showing how aluminum is mined, reduced from powder to metal, cast, rolled, extruded, pressed, and coiled and shaped into end-products ranging from packaging foil to airplane wings.**

***Aluminum in Modern Architecture,* a black-and-white film produced by Richard de Rochemont, runs 13 1/2 min. It is a camera report on how aluminum is revolutionizing concepts of design for churches, schools, offices, factories, and homes. The film will be of special interest to engineers and architects.**

**Produced under the sponsorship of Reynolds Metals Co., the movies may be obtained from Association Films Inc. at the following addresses: Broad at Elm, Ridgefield, N. J.; 561 Hillgrove Ave., La Grange, Ill.; 799 Stevenson Street, San Francisco, Calif.; and 1108 Jackson St., Dallas, Texas.**

## MGGD Newsletter

*(Continued from page 909)*

Copper Co. and other mining firms, he entered into the consulting field in 1938 as an engineer and geologist. In 1942, he joined Western Knapp Engineering Co. as mine plant construction superintendent, leaving in 1944 to accept a job with U. S. Smelting, Refining and Mining Co. where he became assistant to the manager of mines in 1951. In 1953 he was appointed industrial development director, his present position. Mr. Ehrhorn has been active in AIME since 1938, serving as vice chairman and chairman of the Utah Section in 1954 and 1955, and chairman of the Membership Committee of the Mining Subdivision. He is presently chairman of the Peele Award Committee.

**Geology**—H. Richard Gault is professor of geology at Lehigh University, Bethlehem. After graduating from DePauw University, Greencastle, Ind., he received an M.A. degree at the University of Missouri and his Ph.D. at Johns Hopkins University. All of his degrees were in the field of geology. From 1942 until 1946, when he joined the Lehigh faculty, Dr. Gault was engaged in geological investigations for the Alaskan Branch, USGS, working with zinc, copper, tungsten, and uranium deposits. In addition to his teaching, he has done field work with a variety of companies in the Pacific Northwest and the eastern U. S.

**Geophysics**—Harold M. Mooney was born in Northfield, Mass., in 1922. He graduated from Harvard, where he received a B.S. degree in 1943, later earning his M.S. at California Institute of Technology. In 1950 he was awarded the doctorate degree in geophysics. Beginning as an engineer with General Electric, he left in 1944 to work on the Manhattan Project. He joined the faculty of the University of Minnesota, where he is assistant professor of geophysics, in 1950. A member of the Society of Exploration Geophysicists, the Seismologic Society, and the Geophysics Union, Prof. Mooney has been very active in the Geophysics Subdivision of AIME for a number of years.

## UET Grants Used For Engineering Research

Engineering research will go forward on a wide front with new grants made by Engineering Foundation, a department of United Engineering Trustees Inc., at its annual meeting held in New York on May 16. Appropriations for the 1957-1958 fiscal year total $69,000. They will initiate or advance 28 projects, which will receive nearly $1,000,000 in industry support. The projects to which funds have been allocated represent all the important branches of the profession. They are being carried out in university, government, and industrial laboratories all over the country under sponsorship of the major engineering societies.

Alloys of Iron Research is receiving $5000 to continue its work of publishing monographs devoted to important findings on carbon and alloy steels and cast irons. This June the project issued the fourth monograph of a new series, entitled *Boron, Calcium, Columbium, Tantalum, and Zirconium in Iron and Steel,* which is of much interest to the manufacturers of jet engines and guided missiles. The new monograph contains a summary of valuable material on the complex high-temperature alloys that have been developed in the past five or ten years. It is these new alloys which are making jet engines and more efficient power plants possible because they can withstand higher temperatures than ordinary steel. Alloys of Iron Research has been receiving Engineering Foundation support since its formation in 1929. It is a project sponsored by AIME.

An allocation of $4000 goes to the Corrosion Research Council—also an AIME-sponsored project—which completed its first year on Dec. 31, 1956. One of the scientifically important facts already revealed by the Council's first program is that light slows down the rate of corrosion in water containing air. Furthermore, exposure to a beam of light apparently causes the oxide film on metal to dissolve. This research is being done in cooperation with the National Bureau of Standards.

*AIME*

# BOARD OF DIRECTORS

**Recent actions taken by the Institute Board of Directors.**

► A resolution of the Council of Section Delegates for joint action by the Committee on Section and Student Chapter Affairs and a committee appointed by the Council on the matter of Local Section finances was approved. The following committee of the Council of Section Delegates was appointed: David Swan, Chairman; Fred L. Oliver, A. W. Knoerr, Henry Wardwell, and J. W. MacDonald.

► A recommendation by the Steering Committee of the All-Institute Membership Committee that membership contests between Sections and Student Chapters be placed on a more equitable basis, grouping the units according to size, was approved. Although this procedure would entail an increase in the cost of the contests, it was considered desirable.

► The following proposed revisions in the AIME Bylaws and Rules were approved:

*Article II, Section 1a*—Revised to read, "Membership in the Institute shall be divided into Societies. A member's choice of monthly journal(s) shall determine the society(ies) to which he belongs."

Rule to accompany the above Bylaw: "A member's dues, for bookkeeping purposes, will be credited to the Society whose journal he selects as his first choice."

*Article II, Section 2g*—Revised to read, "A student in good standing at a degree-granting school approved by the Board of Directors, who has been nominated by one instructor of the nominee (preferably an Institute member), may affiliate with the Institute as a Student Member."

*Article III, Section 4*—Revised to read, "Disbursement of the Institute funds shall be made by the Treasurer or Assistant Treasurer on checks signed by him and countersigned by the Secretary. The Board of Directors may, from time to time, designate such other persons to sign and/or countersign said checks."

► Ingersoll Rand Co. has contributed $700 to make possible the award of the William Lawrence Saunders Gold Medal in 1958, providing a suitable recipient is selected by the Award Committee. The Board of Directors expressed appreciation to the Ingersoll Rand Co. and to M. L. McCormack through whose efforts the gift was made.

► On recommendation of the Council of Education of AIME, J. R. Van Pelt was appointed to succeed John Cameron Fox as one of the AIME representatives on Engineers Council for Professional Development for a three-year term, beginning Oct. 25, 1957.

► Charles H. Behre, Jr., was appointed official AIME delegate at the Ninth Pacific Science Congress to be held in Bangkok, Thailand, Nov. 18 to Dec. 9, 1957.

► Gordon MacVean was designated official AIME representative to extend greetings at the banquet of the annual meeting of the Mining Society of Nova Scotia which took place June 27 to 29, 1957.

► John C. Calhoun had been appointed AIME representative to the National Education Assn.'s Centennial Convocation in Philadelphia. Unable to accept the appointment, Mr. Calhoun and W. B. Stephenson were directed to select a replacement and notify the Secretary of AIME of their choice; approval was voted of whomever they selected. Subsequently, G. R. Fitterer was appointed.

► Paul T. Allsman and F. L. Vogel having resigned from the Rossiter W. Raymond Award Committee, Robert Gallagher was appointed to succeed Mr. Allsman and Ernest Birchenall to replace Mr. Vogel on the Committee.

► The Nominating Committee of the Council of Education of AIME announces the following nominations for officers in 1958: Chairman, O. C. Shepard; Vice Chairman, L. E. Shaffer; Executive Committee, H. G. Botset, J. W. Amyx, and M. T. Nackowski.

► C. R. Kuzell and E. C. Babson were appointed AIME delegates to the Sixth Commonwealth Mining and Metallurgical Congress which will take place Sept. 8 to Oct. 9, 1957, British Columbia to Nova Scotia, Canada.

► It was announced for the information of the Directors that the McKune Award for 1957 had been presented on April 9 to W. D. Smith.

In 1940 the National Open Hearth Steel Committee of the Iron and Steel Division established an award in memory of Frank B. McKune, for 40 years open hearth superintendent, Steel Co. of Canada Ltd., and a faithful and active pioneer in the work of the NOHC. The award is now given annually to an author or joint authors, not more than 40 years of age, who submits by February 1, the best paper of or under 5000 words on open hearth steelmaking practice. Local Sections of NOHC are encouraged to establish awards, not in conflict with the requirements of the F. B. McKune Memorial Award. These Local Section award-winning papers can automatically be placed in competition for the McKune Award. The award this year was presented to Mr. Smith for his paper *Manufacture of Leaded Steel*. Mr. Smith is open hearth metallurgist, Aliquippa Works, Jones & Laughlin Steel Corp., Aliquippa, Pa. The award was presented to Mr. Smith, in the form of certificate and check, at the Fellowship Dinner of the National Open Hearth Steel Committee on Tuesday, Apr. 9, 1957.

► It was announced for the information of the Directors that the Open Hearth Conference Award for 1957 had been awarded to T. A. Cleary, Jr.

The Open Hearth Conference Award was established a few years ago as a supplement (or runner-up) to the McKune Award, and is based on the same award conditions. Mr. Cleary, who is melter foreman, Youngstown Sheet and Tube Co., Youngstown, won the award for his paper *Factors Affecting Heat Time*. He was also honored at the Fellowship Dinner on Apr. 9, 1957, and received a certificate and a check.

# Pulaski, Va., Site of Central Appalachian Section Spring Meeting

Many of the nation's finest mining and engineering minds participated in the two-day spring meeting of the Central Appalachian Section held on May 24th and 25th. More than 100 engineers and geologists from Virginia, West Virginia, North Carolina, Tennessee, and Kentucky convened at the Maple Shade Inn in Pulaski, Va., for sessions on hard rock and coal mining on Friday afternoon. The morning program provided a series of talks on the Austinville operation of the New Jersey Zinc Co., one of the oldest continually operated zinc and lead mines in the country. W. H. Brown, chief geologist; C. G. Morgenstern, assistant plant superintendent; and W. A. Griffith, mill and maintenance chief of the company's Bertha Mineral Div., commented on the different phases of the operation.

A highlight of the morning session was the talk given by E. F. Osborn, dean of the College of Mineral Industries, Pennsylvania State University, on *Fossil Fuels and Nuclear Energy*. Tracing the development of the petroleum industry from its birth a century ago in the Appalachian region, he predicted a 100-pct increase in energy requirements in the next 10 to 20 years and another comparable increase soon after, due to the explosive rise in world population and the drive to industrialize in underdeveloped nations. Pointing out that nuclear energy may be able to supply as much as 10 pct of U. S. requirements during that period, he stressed the need to produce fossil fuels at an ever increasing rate. Emphasizing the demand for research engineers and scientists for exploration, production, and utilization, he cited his own university's use of industry-sponsored scholarships to achieve this goal.

A new color film produced by International Nickel Co. on the milling and smelting of the Sudbury nickel ores was presented during the morning program.

Sessions relating to materials for nuclear development at the Central Appalachian Section spring meeting provoked some animated discussion among those attending the two-day meeting. Among the participants were, left to right: John T. Sherman, assistant director, Domestic Procurement Div. of Raw Materials, AEC, Washington, D. C.; F. M. Morris, chairman of the Section; and E. F. Osborn, dean of the College of Mineral Industries, Pennsylvania State University, University Park, Pa. Both Messrs. Sherman and Osborn presented papers relating to the raw materials for atomic energy.

### Afternoon Technical Sessions

At the afternoon meeting, two technical sessions were held simultaneously, following luncheon in the ballroom, presided over by F. M. Morris, chairman of the Section. John T. Sherman of the AEC led off at the session on hardrock mining with a discussion of uranium mining and milling, followed by D. D. Jenkins, general foreman at the Austinville mine, who spoke on jumbo vs jackleg drilling in nominal size headings. W. S. Hannan, plant chief of the Bertha Mineral Div., addressed the group on the subject of mine pumping controls at Austinville. A paper on airborne geophysical instruments and exploration by W. B. Agocs of Aero Service Corp. was presented by a representative of the company. The AEC's documentary, *Petrified River*, describing uranium deposits on the Colorado Plateau provided visual data.

At the coal mining session, the following speakers and topics were heard: *Dust Collection with the Microdyne* by A. Lee Barrett, director of research and development, Joy Manufacturing Co., Franklin, Pa.; *Use of A.C. Power on Conventional Mining Sections* by Chester S. Conrad, division maintenance superintendent, Consolidated Coal Co., Fairmont, W. Va.; and *Process in Underground Belt Conveyors* by M. H. Shumate, assistant general manager, Truax-Traer Coal Co., Kayford, W. Va. A discussion led by Robert R. Godard, Frick district electrical engineer, Coal Div., U. S. Steel Corp., Uniontown, Pa., preceded the final paper of the session.

At six o'clock all was well, with members in a social mood attending a cocktail session in the Hunt Room, followed by the Section banquet, at which Representative W. Pat Jennings delivered the main address.

### Field Trips on Saturday

The field trip on Saturday took about 50 of the meeting delegates to the Austinville mine and mill of New Jersey Zinc Co. and included a tour through the entire length of the recently completed Ivanhoe tunnel, a 2½-mile drift connecting the Austinville and Ivanhoe mines. Luncheon was provided by the company for the visitors.

For those who did not wish to tour the mine, there was an alternate trip through the mining laboratory facilities at Virginia Polytechnic Institute.

### Ladies Program

The ladies program, which was arranged by Mrs. W. A. Griffith and Mrs. W. L. Albers, featured a tour on Friday of the Jefferson Mills, a nearby yarn manufacturer, and the Virginia Maid Hosiery Co. plant in Pulaski. In the afternoon the ladies took a sightseeing cruise aboard the Appalachian Electric Power Co.'s yacht at Clayton Lake. While their husbands were mine touring on Saturday, the ladies enjoyed a card party and luncheon.

Officers of the various committees that functioned at the meeting included: W. A. Griffith, chairman, arrangements committee; D. Keith Lupton and Woods G. Talman, co-chairmen, program committee; and W. L. Albers, chairman, field trip committee.

The following members were designated at the meeting to serve on the nominating committee to select the new Section officers: Rhesa Allen, Fred Prosser, G. R. Spindler, Belaire Smith, and R. H. Allen.

# PERSONALS

J. R. VAN PELT

**J. R. Van Pelt** was inaugurated as sixth president of the Michigan College of Mining and Technology, Houghton, Mich., on May 10. Principal speaker on that occasion was **B. D. Thomas** who was awarded an honorary degree of doctor of engineering by the College "in recognition of his high attainments in engineering." Dr. Van Pelt, who succeeded **Grover C. Dillman** as president of the College in October, is a graduate of Michigan Tech with B.S. and E.M. degrees. He also holds A.B. and doctor of science degrees from Cornell College, Iowa, where he began his teaching career. He subsequently worked for the Museum of Science and Industry in Chicago. Prior to coming to Houghton, Dr. Van Pelt had been associated with Battelle Memorial Institute, Columbus, Ohio, and the Montana School of Mines where he had been president since 1951. Since 1952 he had been the representative of the governor of Montana on the Western Governors' Mining Advisory Council. In addition to his long service to AIME, Dr. Van Pelt has been active in the American Soc. of Engineering Education; is a member of ECPD, having served as chairman of the guidance committee for Montana; and has served on the advisory council on scientific personnel of the National Research Council. Dr. Thomas is a director of Battelle Memorial Institute and has been closely associated with the institute's atomic energy research in Columbus, as well as with the establishment of laboratories in Frankfort, Germany, and Geneva, Switzerland. He is a graduate of the University of Washington with B.S. and Ph.D. degrees in chemistry.

B. D. THOMAS

Several employes of the Grand Junction Office, U. S. Atomic Energy Commission, have received cash awards totaling $1110 in recognition of outstanding work performances and for money-saving suggestions. **Charles A. Rasor,** chief of the ore procurement branch, Mining Div., and **Robert H. Toole,** chief of the leasing and development branch, Mining Div., each won $300.

**John L. G. Weysser,** consulting mining engineer, recently completed his work in Pakistan on an assignment by the U. S. Bureau of Mines for the International Cooperation Administration. He served as minerals advisor to Pakistan.

**J. Gary Mitton** was promoted from ore dressing technician to metallurgist-ore dressing for Cerro de Pasco Corp. (Delaware).

**Luis Aguilera** has resigned as director of Hydraulic Works, Ministry of Public Works in Venezuela. He is now manager of the firm Obras Subterraneas in Caracas, Venezuela, engaged in mining exploration and development. Mr. Aguilera is also assistant professor in mining geophysics at the Universidad Central, Caracus, Venezuela.

**Harty S. Berube** is now assistant manager, Gaspe Copper Mines Ltd., Murdochville, Que., Canada. Mr. Berube had been associated with Quebec Lithium Corp., Barraute, Que., Canada.

**Joseph F. Brown** is a mineral examiner with the U. S. Forest Service with headquarters in Flagstaff, Ariz.

**John R. Chambers,** former assistant drilling and blasting boss, Ray Mines Div., Kennecott Copper Corp., Ray, Ariz., has been promoted to shovel foreman.

**Wilbur H. Smith** has joined Ciá Minera Del Tisur, S.A., a subsidiary of Republic Steel Corp. with offices in Mexico City. In his post as exploration geologist, Mr. Smith will be located in Pluma Hidalgo, Oaxaca, Mexico.

**W. J. O'Connor,** president and general manager, Independent Coal & Coke Co., was elected president of the Utah Coal Operators Assn. Among those elected directors were **Oscar A. Glaeser,** vice president, U. S. Fuel Co., and **P. L. Shields,** president of Spring Canyon Co. and Royal Coal Co.

**Mike Evasovic** is now with Standard Slag Co., Gabbs, Nev. He was formerly located at Getchell Mine, Golconda, Nev.

**E. M. Kipp** has joined Foote Mineral Co., Philadelphia, as director of research at the company's Research

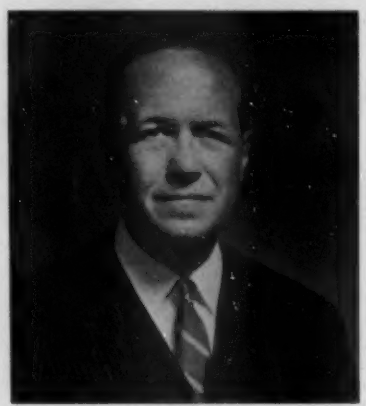
E. M. KIPP

and Development Dept., Berwyn, Pa. Since 1947 Dr. Kipp had served as director for one of the research divisions of Aluminum Co. of America, and had been affiliated with Alcoa since 1939.

**Roy E. Nelson** was elected vice president of American Gilsonite Co., Salt Lake City. He will continue as manager of production.

**Mord Lewis** has been elected executive vice president and director of Anaconda Aluminum Co. He has been associated with Anaconda since 1926, and was made a vice president of Anaconda Aluminum, a subsidiary of The Anaconda Co., in 1956.

**Andrew Fletcher**, president, St. Joseph Lead Co., has been re-elected president and chairman of the board for the Lead Industries Assn.



A. FLETCHER

**Bahngrell W. Brown** was named acting head of the Dept. of Geology, Montana School of Mines, Butte. The appointment of Dr. Brown will enable **Walter S. March, Jr.**, former head of the department, to devote more time to his post as associate director of the Montana Bureau of Mines and Geology.

**Robert G. Page**, president, Phelps-Dodge Corp., has been elected to serve a three-year term on the board of directors of the Commerce & Industry Assn. of New York.

**Hubert Risser**, currently assistant professor in the Dept. of Mining and Metallurgical Engineering at the University of Kansas, Lawrence, Kan., has accepted the post of mineral economist in the Mineral Economics Section, Illinois State Geological Survey, Urbana, Ill.

**Herbert S. Jacobson** has terminated his association with American Smelting & Refining Co. at Patagonia, Ariz. He is now employed by the Bear Creek Mining Co. at Tucson, Ariz.

**Jerry M. Whiting** has completed his work for an M.S. degree at the University of Idaho, and has accepted a position in the Mining Engineering Dept., Aluminum Co. of America at Bauxite, Ark.

**Harry A. Astlett** has been transferred to Wakefield, Mich. He is with U. S. Metals Refining Co., The American Metal Co. Ltd.

**Russell R. Bryan, Jr.**, who was recently in the Dominican Republic, is now back in San Francisco with Russell Bryan and Associates Inc. This firm has just completed the engineering planning of an iron mining operation in Mexico for Las Encinas, S. A. and has been engaged to manage the development of the mine and the construction of all facilities.

**Ed Fern** is now located at Buffalo Mine, Sumpter, Ore., where he is employed as mining engineer.

E. M. WHITE

**E. M. White**, formerly assistant manager of the Mining Dept., Mine Safety Appliances Co., Pittsburgh, has been named sales manager of the Mining Div. He has been with the company since 1937.

**M. L. Urquhart** has been appointed general manager, McIntyre Porcupine Mines Ltd., with headquarters at Toronto. He has been with the firm since 1922, and has been manager of the McIntyre Mine, Schu-

macher, since 1951. Mr. Urquhart is president of the Ontario Mining Assn.

**William W. Staley, Jr.,** has left his post as professor at the School of Mines, University of Idaho, Moscow, Idaho. He is now working in Brazil with the Mineracao Wahchang S.A. and is stationed in Currais Novos, Rio Grande do Norte.

**Norton E. Croft** has been promoted to Pacific regional representative, Allis-Chalmers Mfg. Co. His headquarters will be in San Francisco. Mr. Croft has been supervisor of crushing machinery sales at Allis-Chalmers' processing machinery department since 1952.

**Modesto L. Leonardi** has been promoted to manager of plant production at American Potash & Chemical Corp's main plant, Trona, Calif. He has been with the firm since 1939.

H. Y. BASSETT

**Horace Y. Bassett**, executive vice president, Calumet & Hecla Inc., Chicago, has been elected president and chief executive officer of the company. He succeeds **Endicott R. Lovell**, president for 13 years who has retired from that post but has assumed the executive committee chairmanship and chairmanship of the board.

E. R. LOVELL

**Enzo De Chetelat** has been transferred from the U. S. Operations Mission in Cambodia to the U. S. Operations Mission in Tunisia where he is working as mining geologist.

**Roland J. Schwartz,** has been transferred from the Phoenix, Ariz., branch of the U. S. Atomic Energy Commission to the office in Reno, Nev.

**Allan C. Turnock**, formerly at Johns Hopkins University, Baltimore, is now located at the G.S.C., Uranium City, Saskatchewan, Canada.

**Gary R. Radcliffe** has accepted a post as mining engineer with Kaiser Exploration Co. in Belem, Para, Brazil.

**Robert R. Durk** is now manager of sales for mining equipment, Sanford-Day Iron Works Inc., Knoxville.

R. R. DURK

I. M. LeBARON

W. BELLANO

Several new directors have been elected to the Board of Directors, International Minerals & Chemical Corp., Chicago. They are: **Milton LeBaron,** vice president in charge of research; **William Bellano,** vice president-engineering; and **Anthony E. Cascino,** vice president-marketing.

**Ernest L. Ohle** has been named chief geologist in charge of the geology department of two companies: Copper Range Co. and White Pine Copper Co., Houghton, Mich.

**Kurt Servos**, formerly curator of geology, University of the State of New York, Albany, is now at the School of Mineral Sciences, Stanford University, Stanford, Calif.

**Charles V. Harris** has been promoted to assistant resident engineer for General Services Administration in Nicaro, Oriente, Cuba, and has also been named assistant resident administrator of Cuban Nickel Co. Mr. Harris had been industrial engineer for GSA, working on the $40 million expansion program of the nickel plant at Nicaro.

A. E. CASCINO

New members elected to the executive committee of the Machinery & Allied Products Institute are: **John Lawrence,** president, Joy Mfg. Co., Pittsburgh; and **W. Cordes Snyder, Jr.**, president and chief executive officer, Blaw-Knox Co., Pittsburgh.

**Edmund G. Mitchell** has moved to Bryan, Ohio, the new location for the main office of MENCO Inc., of which he is a senior partner.

**Harry J. Emdin** has been appointed mine superintendent of New York & Honduras Rosario Mining Co.'s El Mochito Mine, located in Via Jaral, Honduras.

**Howard G. Schoenike,** economic geologist of Houston, has resigned as production geologist for the Baroid Div., National Lead Co. Mr. Schoenike will devote full time to domestic and foreign consultation and has his own office at 4039 Turnberry Circle, Houston.

**M. Jacobson** has been appointed president of Mining Equipment Corp., American subsidiary of N. V. Billiton Maatschappij of The Hague, Netherlands.

**Henry Duffy** has assumed the newly created post of vice president-manufacturing, McDowell Co. Inc., Cleveland.

**Clement Matthew Anson** has been chosen president of The Engineering Institute of Canada. He took office in June at the annual meeting of the Institute in Banff, Alberta.

**Herbert M. Weed** is now assistant to the executive vice president, Anaconda Sales Co. He had held the same post at Chile Exploration Co. since 1956.

**H. E. Redenbaugh** is manager of Mine Safety Appliances Co.'s International Div., while **M. L. Symington** has been promoted to export sales manager. He had been administrative assistant to the manager, Industrial Dept.

**Jay B. Ford, Jr.,** has been appointed assistant general manager, Pacific Coast Borax Co. Div., U. S. Borax & Chemical Corp., with headquarters in New York.

**George C. Heikes** has joined Continental Uranium Inc., Chicago, as manager of mineral resources. He was formerly chief mining engineer for National Lead Co.

H. G. SCHOENIKE

**Norman A. Spector**, vice president of Heavy Minerals Co. and assistant general manager, Vitro Engineering Div., has been named vice president, Vitro Corp. of America, New York.

**Willard P. Chamberlain** has joined Cherry Hill Coal Corp. as vice president in charge of finance. He was associated with Cleveland-Cliffs Iron Co. for 25 years.

**G. W. Walton** has been appointed president of the newly organized

Ideco Inc., manufacturers of drilling equipment. Ideco was formerly a division of Dresser Equipment Co. and is now a subsidiary of Dresser Industries Inc.

**B. C. Lansing** has been named special representative for the construction and mining division of Harnischfeger Corp., with headquarters in Los Angeles. In this newly created post, Mr. Lansing will concentrate on the promotion of excavator sales in the western U. S.

B. R. FRISBIE

**B. R. Frisbie** has resigned as Minerals Attache with the American Embassy in Lima, Peru, and has returned to industry. Mr. Frisbie will be working for an American firm in Johannesburg, Union of South Africa.

**Henry A. Arnold** has been appointed president of the new Olin Mathieson International Corp., subsidiary of Olin Mathieson Chemical Corp. He will be responsible for all of the company's overseas activities.

**Joseph C. Duke** and **Bert S. Cross** vice presidents of Minnesota Mining & Manufacturing Co., were elected to the firm's board of directors.

**Herbert H. Harris** has joined the technical service staff of Diamond Alkali Co.'s chlorinated products division, Cleveland.

**Edwin H. Snyder,** vice president in charge of electric operations of the Public Service Electric & Gas Co., Newark, N. J., was elected senior vice president of Lehigh University Alumni Assn. **Howard S. Bunn,** executive vice president, Union Carbide & Carbon Corp., New York, was elected alumnus trustee of the university for a six-year term.

**Wayne H. Burt,** has been awarded a Sloan Fellowship for participation in the executive development program at Massachusetts Institute of Technology, Cambridge, Mass. Office engineer-operations at the New York office of Kennecott Copper Corp., he began his one year of study at MIT in June. He was one of 36 to receive this honor.

C. H. RIEMAN

Three vice presidents were elected at Gardner-Denver Co., Quincy, Ill. They are **C. H. Rieman, George W. Gutekunst**, and **Brice D. Maddox.** Mr. Rieman, who has been with the company since 1937, was formerly sales manager of mining and construction equipment until transfer to the Denver plant in 1955. He was named general manager there last February.

**Evaristo Martinez** is working for the Gardner Denever Co., as their Colombia representative, and is stationed in Bogota.

**Wilfred A. Lyons** has accepted a post as geologist with Corporación Minera de Bolivia in La Paz.

**Bruce D. Crawford** has left Johannesburg, Union of South Africa, to return to the U. S. Mr. Crawford was associated with South African Cyanamid Co., a subsidiary of American Cyanamid Co., for 29 years.

**R. Lee-Aston** is now plant engineer for the Signal Mountain Div. of the General Portland Cement Co.'s plant and quarry at Chattanooga, Tenn.

**Robert W. Crabtree,** manager of nitrogen product sales for Hercules Powder Co.'s Explosives Dept., has been named manager of chemical sales, a newly created post. He has been with the department since 1934.

# OBITUARIES

**Walter Curran Mendenhall**

An Appreciation By
Charles H. Behre, Jr.

Walter Curran Mendenhall (Honorary Member 1913), who retired as Director of the United States Geological Survey on Mar. 1, 1943, died at his home in Chevy Chase, Md., on June 2, 1957, after a long illness. His age was 86. Most of the last decade of his life had been spent quietly but in continued association with old friends who cherished these visits and the warm feelings of loyalty and affection that the occasions always engendered.

Born in Marlboro, Ohio, Feb. 20, 1871, he appeared, as a boy, to have been oriented early toward scientific activities. After earning the Bachelor's degree at Ohio Normal University in 1893, he studied at Harvard in 1896 and 1897, and then at the University of Heidelberg for two years. Though he did not complete his studies toward a formal graduate degree, he later received honorary doctorates from the Colorado School of Mines and the University of Wisconsin.

While at Harvard, Mendenhall had been attracted to a career in the USGS. He entered this service in 1894 as a geologic aid, becoming assistant geologist thereafter and rising to the rank of geologist in 1901. Six years later he was put in charge of ground water investigations, and in 1910 was made head of the land classification board (now the Conservation Div. of the Geological Survey), a post that he held for 12 years.

In 1922 under George Otis Smith, Dr. Mendenhall was advanced to the position of chief geologist on the Geological Survey, succeeding the well known coal geologist and paleobotanist David White. In 1930, when Dr. Smith was assigned to the Federal Power Commission, it was necessary to designate someone who could act for the director, and Dr.

*(Continued on page 924)*

## Obits

*(Continued from page 923)*

Mendenhall was asked to serve in that capacity. This office—difficult not only because of the complexity of its responsibilities but also because of the apparently temporary nature of the appointment—was discharged with skill, the incumbent exercising both tact, in regard to his associates who were formally coequal, and effectiveness in instituting the necessary steps for widening progressively the operations of the Survey. In 1933 he was given the full title and office of director.

Before his growing responsibilities as an administrator absorbed his entire time, Dr. Mendenhall contributed studies of much importance to an understanding of the regional geology of the United States. His first work was in conjunction with Marius R. Campbell, one of those gifted and many-sided field men on the USGS who laid the groundwork of American geology. In 1899 Mendenhall began studies in Alaska, to which he was to return occasionally during the next two decades of his work. In the early part of the current century, attention began to be directed toward underground water and Mendenhall reoriented himself toward this special work with particular attention to parts of California and Nevada, where the problems of water supply were critical and basic to settlement. But by 1930, overwhelmed by the varied and numerous responsibilities of the acting directorship and later of the full post, Mendenhall withdrew almost wholly from personal work in geology, although he remained greatly interested in what was, as he once put it with typical modesty, "going on out there." In these later years he referred to himself as having the responsibility of "making it possible for other people to do the important work," by which he meant investigating and reporting.

Mendenhall was a member of the principal geological and related societies—a fellow of the American Assn. for the Advancement of Science, of the GSA (president in 1936), a member of AIME and honorary member in 1944, an honorary member of the American Assn. of Petroleum Engineers, member of the National Academy of Sciences, and a recipient of the Penrose Medal of the SEG. He also had much to do with recognition of the role of the government scientist, who prior to Dr. Mendenhall's effective championship, was largely regarded as a kind of clerk.

In 1915, Dr. Mendenhall married Alice May Boutell, who, with their two daughters, Alice C. Mendenhall of Menlo Park, Calif., and Mrs. Margaret B. Smith of Chevy Chase, Md., survives him.

Ever a bit reserved and a bit inward turned, in the eyes of those who did not know him well, Dr. Mendenhall on occasion uncovered charming bits of deep and philosophical humor. Perhaps his outstanding quality was an ingrained humility: to those who knew him well, he had the flavor of the *salt of the earth* rather than a sharper, more striking, and perhaps more tart seasoning. His role in building and maintaining the Geological Survey through troubled years should stand as a satisfying monument to any man!

**John C. Andersen** (Member 1948) died in an airplane accident in Central America on Dec. 12, 1956, at the age of 36. A native of Brush, Colo., he attended the Colorado School of Mines, receiving a degree in mining engineering in 1945. At the time of his death Mr. Andersen was employed as project manager for Kaiser Aluminum & Chemical Corp. at Spur Tree, Jamaica, B.W.I.

**Daniel M. Coxe** (Member 1942) died recently. A native of Philadelphia, he studied at Harvard, Haverford, Yale, and the University of Pennsylvania. At the time of his death he was coal land agent for the estate of Tench Coxe, formerly president, Angas Corp, Drifton, Pa.

**Wordsworth C. Elliott** (Member 1947) died in September 1956 at the age of 50. Born in Newcastle, Neb., he attended the University of Nebraska. Mr. Elliott joined Root & Norton, Assay Office in Durango, Colo., as a partner in 1933, becoming sole owner in 1942.

**Joseph Francis Joy** (Member 1950) died on Feb. 19, 1957. He was born in Cumberland, Md., on Sept. 13, 1883. President of the Joy Mfg. Co., Pittsburgh, since 1919, he was also consulting engineer to the Russian Government from 1925 to 1927. Mr. Joy served as senior ordnance engineer, U. S. Office Chief of Ordnance, War Dept., during World War II. Since 1945 he had been a consulting mining engineer. His article on coal mining machinery appeared in the *Encyclopedia Americana*. Mr. Joy was the recipient of the War Dept. Civilian Citation and the National Manufacturers Assn. Pioneer Scroll.

**Walter Leon Goldstein, Jr.** (Member 1936), died Jan. 22, 1957. A native of Goldston, N. C., he attended the University of North Carolina where he received his B.A. and M.A. degrees. Mr. Goldston's first job was with Empire Gas & Fuel Co. as field geologist. During World War I, he was a second lieutenant in the U. S. Army. He was chief geologist for Texas Unity Oil Co. and Cranfill-Reynolds Co. In 1936 he formed a partnership, opening Goldston-Stevens, consulting geologists.

**George D. Louderback** (Member 1918) passed away on Jan. 27, 1957, at age of 82. He was born in San Francisco and received his B.A. and Ph.D. degrees at the University of California. His long career in the academic world began in 1900 at the University of Nevada where he was professor of geology and mineralogy. In 1906 he returned to his alma mater as assistant professor of geology, leaving in 1914 to head a geological expedition in China for Standard Oil Co. of New York. The year 1917 saw him back at the University of California as professor of geology.

**Ernest J. Maust** (Member 1936) died recently. Born in Salisbury, Pa., in 1902, he attended Carnegie Institute of Technology and graduated from the University of Pittsburgh in 1925 with a B.S. degree in mining engineering. Mr. Maust's career began with a job as junior mining engineer with the U. S. Bureau of Mines in Birmingham. Later posts took him to Nicaragua, and Colombia. At the time of his death he was associated with Western Machinery Co. in New York, in the capacity of consulting metallurgical engineer.

**Donald H. McDougall** (Member 1919) died on Dec. 4, 1956. He was president of MacKinnon Structural Steel Co., Ltd., Montreal. Born in Nova Scotia in 1879, Mr. McDougall studied at Dalhousie College in Halifax. He was associated with Dominion Coal Co. Ltd., and had been president of Nova Scotia Steel & Coal Co. Ltd. Mr. McDougall became president of MacKinnon in 1938.

**James W. Morgan** (Member 1947) died on Feb. 1, 1957 at the age of 57. He was born in Washington, D. C., and obtained a degree in mining engineering from Lehigh University, Bethlehem. Beginning as mine clerk at C. A. Hughes & Co., Cresson, Pa., in 1921, he rose to become vice president of the company in 1932. In 1943 he was appointed assistant deputy Coal Mines Administrator, Dept. of the Interior, Washington, D. C. At the time of his death he was president, Ayrshire Collieries Corp., Indianapolis, a post he had held since 1950.

**Alexander C. Munro** (Member 1918) died Nov. 15, 1956, at the age of 73. A Canadian by birth, he attended school there, and came to the U. S. in 1899 as a teacher in Michigan. His various jobs took him to Mexico, Canada, and throughout the U. S. Mr. Munro worked for Consolidated Copper Co., Anaconda Copper Co., and San Francisco Mines of Mexico Ltd. He had been general superintendent of mills, Britannia Mining & Smelting Co., Britannia Beach, B. C.

**Harold M. Smyth** (Member 1915) died Dec. 19, 1956. He had been president and general manager of The St. Clair Coal Co., St. Clair, Pa., a position he assumed in 1927. Mr. Smyth graduated from Lehigh University in 1912 with a degree in mining engineering. After a brief stint with the Philadelphia & Reading

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**Continued on Page 926**

Coal & Iron Co., he joined St. Clair as engineer and stripping foreman.

**V. F. Parry** (Member 1948) died recently. Born in Golden, Colo., in 1899, he obtained an engineering degree at the University of Utah and his M.S. at Carnegie Institute of Technology in 1923. From 1923 to 1931, Mr. Parry was associated with Combustion Utilities Corp., Henry L. Doherty Co., where he was in charge of research in carbonization and gasification of coal and oil. At West Virginia University, where he was professor of gas engineering from 1931 to 1937, Mr. Parry continued his research. During this time two of his papers, dealing with flow of gas in coal mines, were published by AIME. Later he became supervising engineer and principal fuel technologist, USBM office in Golden, Colo. His activities there joined research investigations to development work and established his position as an author, with the publication of 21 papers on the properties and utilization of coal.

## Necrology

| Date Elected | Name | Date of Death |
|---|---|---|
| 1939 | C. G. Atchinson | Apr. 27, 1957 |
| 1915 | L. A. Callaway | Unknown |
| 1946 | Harold M. Holkestad | Apr. 23, 1957 |
| 1956 | Tony Skubic | February 1957 |
| 1944 | George H. Wyman | Unknown |

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## Coming Events

**Aug. 19-23,** Sixth National Clay Conference, University of California, Berkeley, Calif.

**Aug. 24,** AIME Adirondack Section, golf and symposium on quality control in geology, mining, and milling, Country Club, Tupper Lake, N. Y.

**Sept. 5-7,** New Mexico Geological Soc., 8th annual field conference, Durango-Silverton-Ouray area, southwestern Colorado.

**Sept. 8-Oct. 9,** Commonwealth Mining and Metallurgical Congress, British Columbia to Nova Scotia, Canada.

**Sept. 9-12,** American Mining Congress, annual convention, Utah and Newhouse Hotels, Salt Lake City.

**Sept. 13,** AIME St. Louis Section, joint meeting with Amer. Chemical Soc. St. Louis Section. Hotel York, St. Louis.

**Sept. 18-21,** International Mineral Dressing Congress, Royal Inst. of Technology, Stockholm, Sweden.

**Sept. 19,** AIME Utah Section, *The Story of Mining and Milling at the Calera Mining Co., Cobalt, Idaho,* by E. B. Douglas, manager of the company, Newhouse Hotel, Salt Lake City.

**Sept. 28,** AIME Adirondack Section, visit to Barton Mines Corp., North Creek, N. Y.

**Oct. 3-5,** Seventh Annual Exploration Drilling Symposium, University of Minnesota, Center for Continuation Study, Minneapolis.

**Oct. 6-9,** AIME Society of Petroleum Engineers, fall meeting, Adolphus, Baker, and Statler-Hilton Hotels, Dallas.

**Oct. 10-11,** ASME-AIME Coal Div., Joint Solid Fuels Conference, Chateau Frontenac, Quebec.

**Oct. 15-18,** AIME, Society of Mining Engineers Annual Meeting and Southeastern States Mining Conference, Hillsboro and Tampa Terrace Hotels, Tampa, Fla.

**Oct. 30-Nov. 1,** AIME Rocky Mountain Minerals Conference, Denver.

**Nov. 8-9,** AIME Central Appalachian Section, West Virginia Mining Inst., joint meeting, Greenbrier Hotel, White Sulphur Springs, W. Va.

**Nov. 11-14,** Society of Exploration Geophysicists, 27th annual meeting, Statler-Hilton Hotel, Dallas.

**Feb. 16-20, 1958,** AIME Annual Meeting, Hotels Statler and Sheraton-McAlpin, New York.

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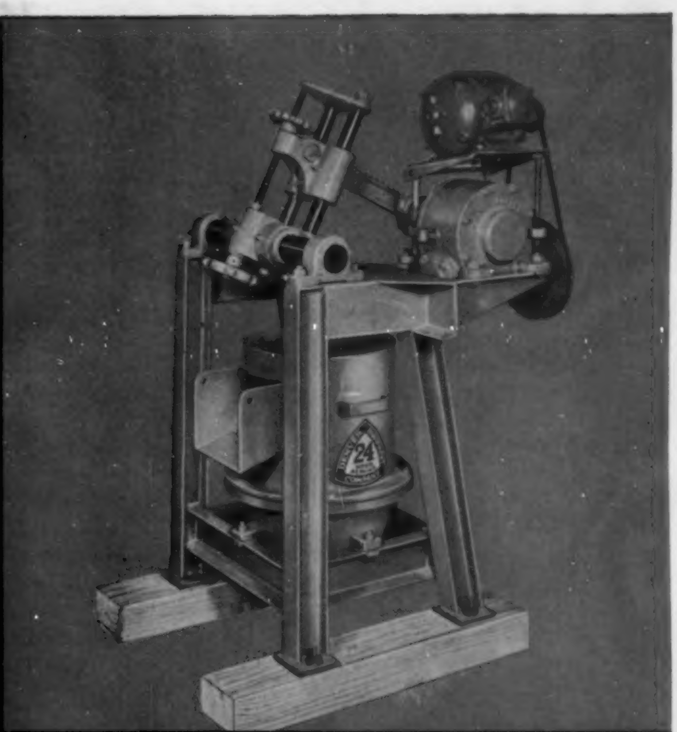

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